# CIVIL ENGINEERING

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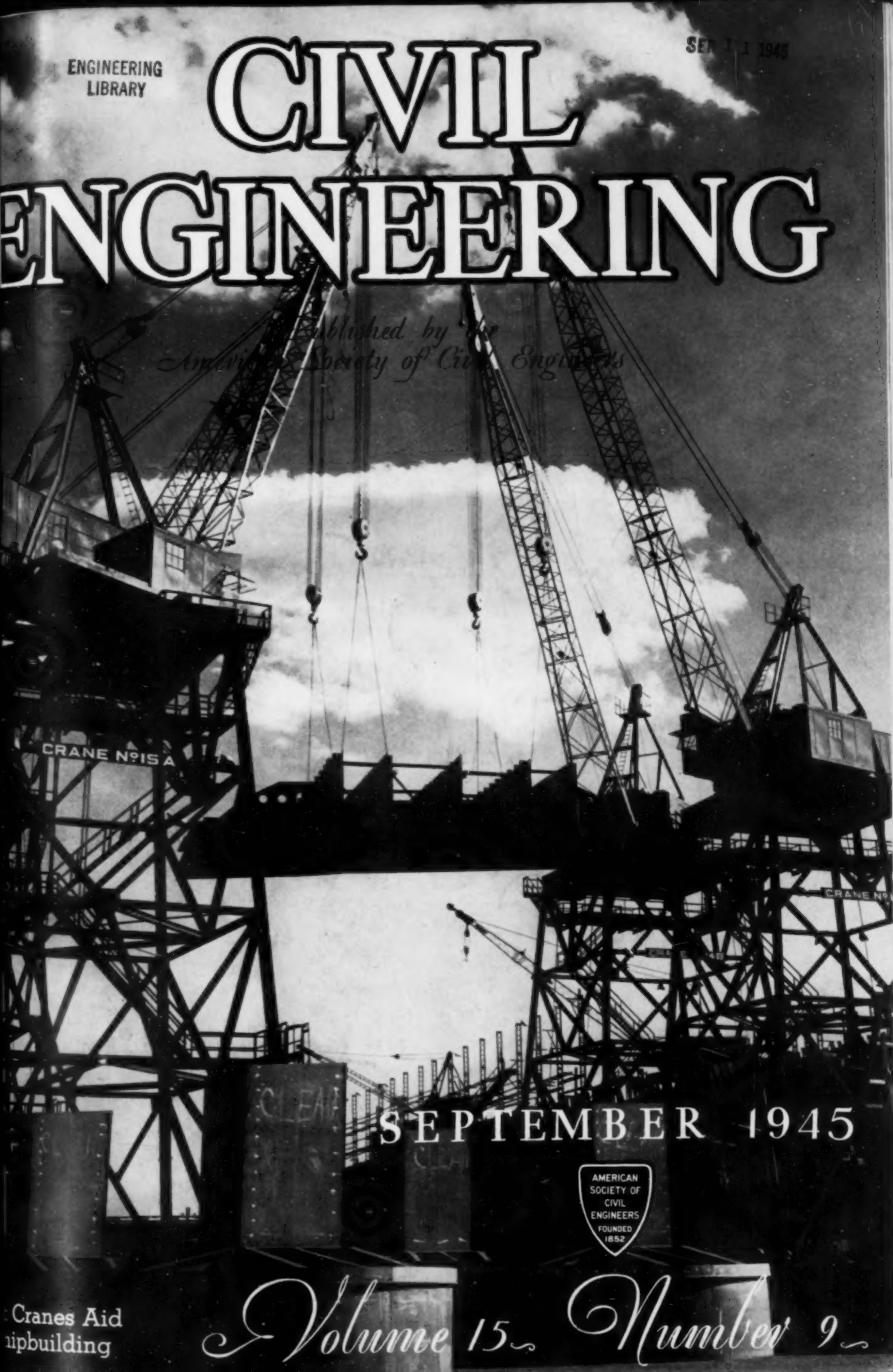


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AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

*Volume 15 Number 9*

Cranes Aid
ipbuilding

# Among Our Writers

George K. Leonard (U. of Nebr., B.Sc.C.E. '12, C.E. '39) until 1933 was contracting engineer and general construction supt. for Woods Bros. Const. Co. Since that time he has been with TVA as Construction Engineer on Wheeler, Guntersville, Watts Bar, and Cherokee dams, and Project Manager on the Hiwassee Projects. He now heads the TVA Project Planning Div.

F. W. Pearce (U. of Mich., B.S. in C.E. '24; U. of Tex., M.S. in C.E. '32) served as engineer with the Sanitary Dist. of Chicago for 4 years and later in the Mich. State Highway Dept. He has had over 10 years of college teaching experience in engineering, surveying, and mathematics. Since 1942 he has been Head of Engineering, Northern Montana College.

William L. Havens (Cornell U., C.E. '16) spent 6 years with the City of Cleveland, Subdivision of Sewage Disposal, becoming Principal Asst. Engr. Since 1922 he has been associate and partner in Havens and Emerson, supervising report preparation and design of water supply and sewage treatment projects.

Frank Woodbury Jones (Worcester Poly. Inst., Chemistry '09) following experience as Chief Chemist for Fitchburg, Mass.; Asst. Engr. N.Y. State Dept. of Health; and Asst. Engr., Subdivision of Sewage Disposal, City of Cleveland, entered the firm of Havens and Emerson in 1923, and is now a partner.

Joseph D. Bodman (Wash. State Col., B.S. in C.E. '38) has located logging railroads in Washington and spent 3 years in mining engineering and air-base construction in Fairbanks, Alaska. Since 1941 he has worked with the Seattle District, U.S. Engineer Office, on Alaskan military projects.

Robert Y. Hudson (Tenn. Tech., B.S. '36, and State U. of Iowa, B.S. in C.E., '39) entered the employ of the U.S. Waterways Experiment Station in 1937, and has been Chief of the Wave Action Section since 1943.

John P. Fitzgerald (Rensselaer Poly. Inst., C.E. '31) spent 6 years in general engineering work with a firm of landscape architects, 3 years as asst. engineer on the design and construction of La Guardia Field, and 4 1/2 years in shipbuilding design and construction. He is now a structural designer for power and industrial plants.

W. N. Taggart (Lafayette Col., B.S. in C.E. '41) was with the Pennsylvania RR before he entered the Navy's Civil Engineer Corps in 1942. He has been in the Southwest Pacific with the 84th Naval Construction Battalion and is now in the Public Works Transportation Dept., Naval Supply Depot, Mechanicsburg, Pa.

E. C. Itschner, (U.S. Mil. Acad.; Cornell U., C.E. '26) now a colonel, has been in the Corps of Engineers, U. S. Army, since 1926. His work has included roads in Alaska, Mississippi canalization, and important duty in the European theater of operations in World War II.

Alfred R. Golzé (U. of Pa., B.S.C.E. '30) has had 15 years of service with the U. S. Government in engineering and administrative capacities in the Interstate Commerce Commission, Bureau of Reclamation, and Bureau of the Budget. He recently rejoined the Bureau of Reclamation.

Frank B. Maltby (U. of Ill., B.S. '82), following his work on the Panama Canal, which he recalls in this series of articles, was chief engineer for several contracting firms. For his work as Lt. Col. of Engineers in France, 1917–1919, he received the Legion of Honor. Back in civil life, he carried out a variety of important assignments (including hydroelectric, waterway, and harbor work) under private and government auspices. He died in 1942.

David F. Bauer has been almost continuously in government service since 1933. He has been with the Office, Chief of Engineers, since building construction was transferred to it from the Office of the Quartermaster General, serving as consultant on prefabricated buildings. Before 1933 he was with several Washington architects as chief draftsman and office manager.

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Volume 15 — September 1945 — Number 9

# Lining the Eight-Mile Apalachia Tunnel

*By* George K. Leonard, M. Am. Soc. C.E.

Project Manager, Hiwassee Projects, Tennessee Valley Authority, Knoxville, Tenn.

*Connecting Apalachia Dam with its power plant downstream is a tunnel 18 ft in diameter and eight miles long. For a good share of its length this tunnel had to be lined with concrete, and in some spots having little cover, with steel. In describing the lining procedure, George K. Leonard gives quantity and cost figures in addition to other pertinent data. A general description of the Apalachia tunnel project was given by Mr. Leonard in the January issue.*

The 22-million-dollar Apalachia hydroelectric project was constructed to augment dense power demands. To meet the schedule, the 8-mile tunnel was excavated in 11 months and the lining was placed in $9^1/_2$ months, while the dam and power house were being built (Fig. 1). With the exception of a 6,000-ft section, which was drilled through excellent rock under 00 ft of cover, the entire 42,725-ft length of the power tunnel was lined.

This schedule required the use of an unusual amount of concreting equipment, for concrete had to be placed in the dam, in the power house, and at several points in the tunnel simultaneously.

Steel liners, 16 ft and 18 ft in diameter, were placed at the four adits and under Deep Branch and Wolf Creek, where the cover was thin. Underground they were backed up with a 12-in. minimum thickness of concrete. Across the adits at Apalachia, McFarland, and Smith Creek they were protected with concrete covers having spillways for the passage of the creeks over them. At Turtletown Creek an open penstock was erected over the creek on piers and coated with camouflage paint. The rest of the tunnel was lined with unreinforced concrete designed to have a 12-in. minimum thickness but, owing to overbreak, it averaged about 2 ft in thickness. Except for the two 12-ft sections between the wye and power-house penstocks, it had an 18-ft inside diameter. In the tunnel lining proper, 199,430 cu yd of concrete were placed, excluding that placed in the intake and power-house penstock supports, anchor blocks, surge chamber, and butterfly-valve house.

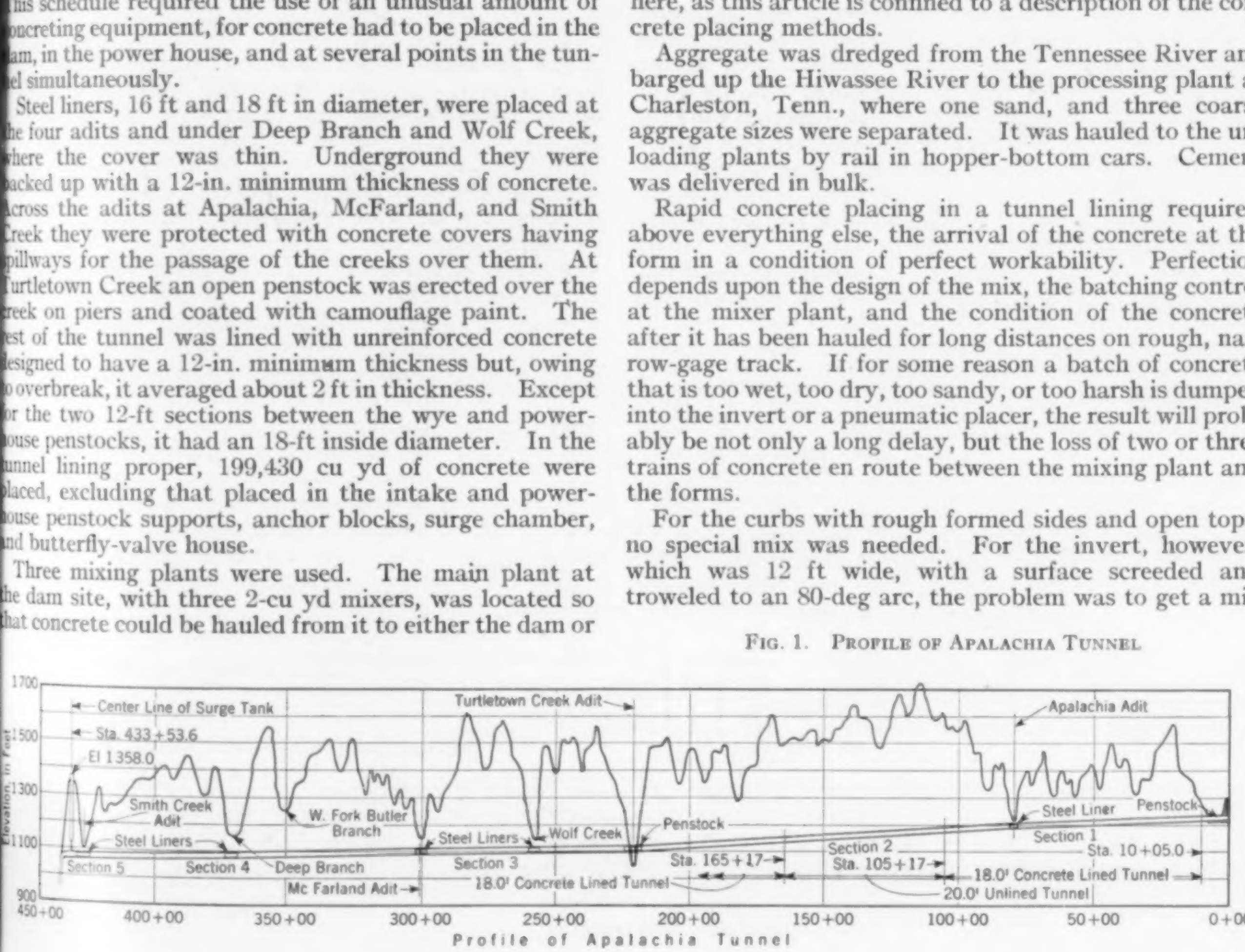
Three mixing plants were used. The main plant at the dam site, with three 2-cu yd mixers, was located so that concrete could be hauled from it to either the dam or the tunnel. Concrete for Sections 1 and 2 was mixed here. Concrete for Sections 3 and 4 was mixed at a plant at the McFarland adit. This plant—complete with facilities for unloading, conveying, and storing aggregate and cement—used three 1-cu yd mixers. Section 5 was mixed at a small plant at the power house. Although the material handling and mixing plants at all locations embodied many novel features, they will not be described here, as this article is confined to a description of the concrete placing methods.

Aggregate was dredged from the Tennessee River and barged up the Hiwassee River to the processing plant at Charleston, Tenn., where one sand, and three coarse aggregate sizes were separated. It was hauled to the unloading plants by rail in hopper-bottom cars. Cement was delivered in bulk.

Rapid concrete placing in a tunnel lining requires, above everything else, the arrival of the concrete at the form in a condition of perfect workability. Perfection depends upon the design of the mix, the batching control at the mixer plant, and the condition of the concrete after it has been hauled for long distances on rough, narrow-gage track. If for some reason a batch of concrete that is too wet, too dry, too sandy, or too harsh is dumped into the invert or a pneumatic placer, the result will probably be not only a long delay, but the loss of two or three trains of concrete en route between the mixing plant and the forms.

For the curbs with rough formed sides and open tops, no special mix was needed. For the invert, however, which was 12 ft wide, with a surface screeded and troweled to an 80-deg arc, the problem was to get a mix

Fig. 1. Profile of Apalachia Tunnel




Profile of Apalachia Tunnel

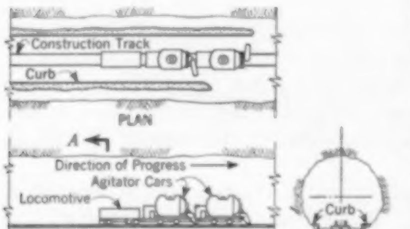
which was soft enough to screed but stiff enough to stay in place along the side forms or on the slopes after the screed and finishing bridge had passed. If it was too stiff, the concrete under the troweled surface was porous. An increased sand content with a 2-in. slump provided proper characteristics.

For the arch concrete, which was placed pneumatically, the proper mix was found after making extensive laboratory and field tests. It required a slump of 7 to 8 in. at the mixer in order to arrive at the gun with the desired slump of 5 to 6 in. The sand and cement content were high to give "lubrication" in the discharge pipe. The water content varied with the temperature and length of haul. Enough water was needed to keep the mix soft and plastic. The test of a good mix was the ability to blow the charge from the pneumatic placer without segregation. If the paste was too wet, and blew out first, the coarse aggregate clogged the pipe; if the mix was too stiff, it would also clog the pipe. The mix might even be plastic enough to go through the gun but still not soft enough to flow properly behind the forms. The mixes shown in Table I were found to be satisfactory when used with well-graded river gravel.

TABLE I. CONCRETE MIXES FOR TUNNEL LINING

| Location | Gravel, Max. Size | Slump | Water-Cement Ratio | Cement per Cu Yd | Percentage of Sand |
|---|---|---|---|---|---|
| Curb | 1½ in. | 3–4 in. | 0.55 max. | 1.30 bbl | 26% |
| Invert | 1½ in. | 2–3 in. | 0.60 max. | 1.35 bbl | 30% |
| Arch | 1½ in. | 5–6 in. | 0.60 max. | 1.58 bbl | 41% |

The concrete was hauled in 5-cu yd electrically powered agitator mixer drums mounted on the reinforced trucks of obsolete 5-cu yd wood dump cars. The drums were charged through a hatch in the side and discharged from one end, during rotation, into a swivel chute. High speed was necessary and 2- to 4-car trains pulled by 15-ton diesel locomotives transported all the concrete over the 36-in.-gage railway system. While en route, rotation was impossible, but upon arrival at the form, 440-v power was plugged in, and after a few revolutions the concrete was ready for placing. Of the 28 cars available, 22 were in service on the maximum haul of 22,000 ft.




Two sets of tunnel lining equipment were purchased so that either invert or arch placing could proceed simultaneously at two locations but, as will be explained, they were not used as originally planned. Each set (see Fig. 2) included 260 ft of 18-ft-diameter, collapsible steel arch forms in 20-ft sections with transfer traveler; a 430-ft-long bridge assembly for pouring the invert, which included a 350-ft pouring bridge and 80-ft incline; a 20-ft invert screed; a finisher's bridge; a 495-ft-long bridge assembly for pouring the arch, which included a 48-ft incline, a 210-ft California switch platform, a 125-ft ramp, and a 112-ft concreting platform; a 210-ft California switch platform with 2 inclines for use at any desired point along the tunnel track; and 2 pneumatic placers.

The concrete lining was placed in three steps. First, the curbs were accurately finished to line and grade, since they served both as supports and as guides for the invert forms and placing equipment. The agitator car chutes placed the concrete directly in the curb forms.

The invert equipment was designed for intermittent placing, the plan being to pour about 50 ft of invert and then move the entire bridge ahead for another 50-ft run. This plan would have slowed down the mixing plant and allied operations from 75 to an average of 25 cu yd per hour, and would have lowered the crew efficiency and increased the cost. One invert pouring bridge was accordingly lengthened to 600 ft by taking 250 ft from the other 350-ft bridge, thus making it long enough to take the entire 8-hour output of the McFarland plant. Its use resulted in a very efficient pouring cycle.

## CURBS POURED FIRST

The procedure was as follows. After the curbs had been poured, the muck-track rails were removed and lined up on 14-ft centers on the curbs in position to take the invert placing bridge. These rails also carried the invert cleaning shield. After the invert was cleaned, concrete was poured through the bridge from the cars directly over it. Low metal side-forms were bolted to the curb, and on them rode the weighted metal screed, which was pulled ahead by an air hoist. Following the screed came the bridge on which the finishers rode, which they pulled ahead by hand. Pouring progressed away from the mixing plant.

Of the three 8-hour shifts, one shift poured about 600 ft of invert and cleaned the bottom for the next day's run. During the other two shifts the cleaning was finished and the bridge and forms were moved ahead, the forms first being loosened and suspended from the bridge. The freshly poured invert was then coated with bituminous membrane curing com-

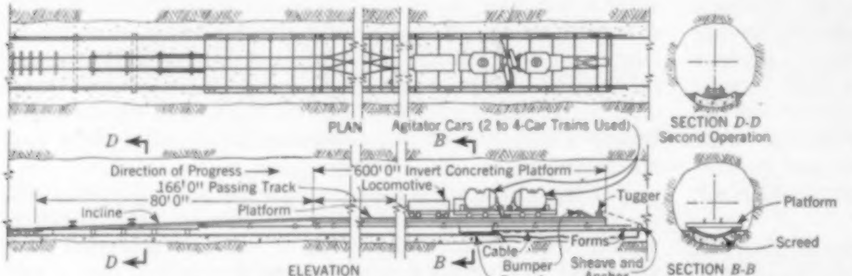
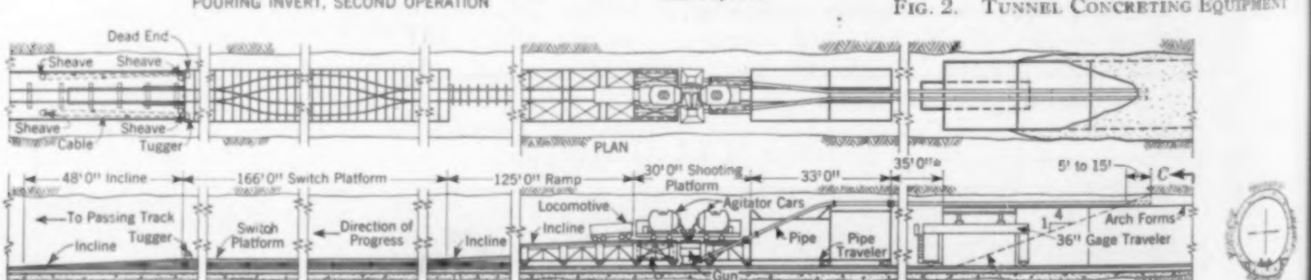



FIG. 2. TUNNEL CONCRETING EQUIPMENT

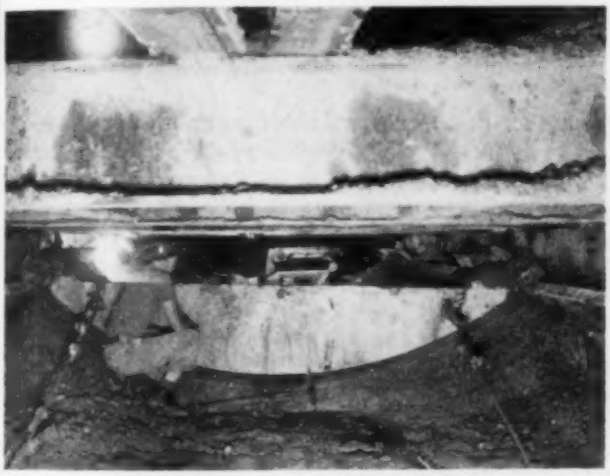


ground. A 6-ft-wide strip of sisal paper was laid along the bottom, and the main hauling track was extended over it by replacing the rails from which the bridge had just been moved.

Use of this paper made final clean-up, which is usually very expensive, relatively simple. Drippings from concrete cars, waste concrete from the arch pourings, spilled grout and other dirt, of which there is an enormous quantity, were to a great extent confined to the paper and did not have to be chipped from the invert surface. The coating of bituminous curing membrane, and a steel-trowel instead of a wood-float finish, also assisted in keeping the waste from bonding with the surface.

Placing of the arch concrete behind the metal forms was done through 6-in. pipe by 1-cu yd pneumatic concrete guns. Placing was continuous, the entire placing assembly being moved ahead on the track on the invert after about 50 ft of forms had been filled. The shooting lines remained embedded in the fresh concrete at the top of the arch. The shooting bridge was high enough to allow gravity feed from the cars through a receiving hopper to the gun.

The original arch shooting bridge accommodated 4-car trains with a gun located on each side so that two cars could discharge simultaneously into each gun. Both guns had to be used, since each discharged 2 ft off the tunnel center line, and the load of wet concrete against each side of the form had to be kept balanced. A plug in one discharge line stopped both guns. Then too, it was extremely difficult to move the long bridge around a curve, and three days of lost time usually resulted.



Screed for Invert Rides on Invert Form Under the Pouring Bridge

After a short period of arch pouring it was found that 260 ft of forms were not enough to permit full, continuous plant production at 75 cu yd per hour. This rate would advance the placing about 23 ft per hour. Allowing 8 hours for stripping time, 304 ft were required, of which 184 ft were needed for filling, 80 ft for the slope, and 40 ft for stripping and setting. The 8-hour stripping time was adequate for summer temperatures but 12 hours were needed in the colder months. This required 416 ft of forms, and to provide this length, 156 ft were taken from the other set.

The final arrangement of the bridge accommodated only 2 cars, and one gun was placed on each side so that both cars could discharge simultaneously into either gun. The shooting bridge and switch platform were shortened to make a total assembly length of 369 ft. This reduced the lost time on curves by 50%.

Pouring Concrete Curb—Bolts for Invert Form Are Embedded in Surface

Only one gun was used, the other being held in reserve in case a line became plugged. Each gun discharged at the top of the arch form and filled both sides at the same rate. This practically eliminated plugging delays and the resulting loss of concrete between the mixer plant and the gun. Whereas a gun discharge of 40 to 60 cu yd per hour had been anticipated, carefully planned operations and well-designed and mixed concrete made rates of 60 to 80 cu yd per hour easily attainable. Rates of over 90 cu yd were common for short periods. Plenty of air at adequate pressure, and shooting lines under 175 ft long, were necessary to maintain high production.

Form sections were collapsed and moved ahead beneath those being filled by a motor-driven traveler at the rate of one about every 50 minutes. Pouring progressed toward the mixing plant. The original traveler was built with 7-ft 8-in. gage, requiring a separate track with special ties, which was difficult and expensive to build and hold in place. It was altered so that it could travel on the track of 36-in. gage which was already in place on the invert, thus effecting further economies.

With the changes that have been mentioned, the capacities of the mixing plant and placing equipment were about balanced. Invert pouring proceeded at the rate of 500 to 600 cu yd per 8-hour shift, which produced about 550 ft of invert. The maximum advance was 600 ft. Arch progress of about 400 ft per day required 1,400 to 1,600 cu yd of concrete. The maximum output for one shift was 800 cu yd, and the maximum day's run was 1,920 cu yd.

Shortly after an arch-form section had been moved ahead, a small crew of finishers, working from scaffolds built on a flat car, repaired surface flaws in the lining and prepared it for the spray coat of bituminous membrane curing compound. This was applied by a crew that followed close behind the finishers.

### STEEL LINING WELDED

The steel lining was installed after the concrete lining had been finished. The sections, 16 and 24 ft long, were transported to position on a low dolly running on the 36-in.-gage track. Those under Deep Branch and Wolf Creek, being 16 ft in diameter, were hauled through the concrete-lined section. After the sections had been lined up and supported on jacks, the circumferential joints were welded. When the entire length was finished, the wood transition forms were built and the concrete backing was placed with a stationary setup of the gun. The

ARCH FORMS COLLAPSED ON TRAVELER FOR MOVE TO NEW LOCATION

steel spiders remained in place until the concreting was finished. All timbering remained in place and was embedded in the concrete. Prefabricated wood forms were used for the "T" at the surge shaft, the "Y," the 12-ft tunnels, and the transitions between the 18-ft concrete and the 16-ft steel sections. The interior surface was cleaned and coated with hot bituminous enamel. The total cost of the steel lining in place was $316 per ton.

Finally, after a wait of as long as possible for the concrete lining to cool and contract, a two-stage neat cement grouting program was started. During the first stage, a rather thick grout, at a pressure of 100 lb per sq in., filled the void between the rock and the concrete lining. During the second stage, a thin grout, at a pressure of 300 lb per sq in., consolidated the rock and made the lining practically watertight.

Grout holes for each stage were drilled on 20-ft centers along the crown, through the concrete lining and into the rock behind it. In timbered sections, grout pipes on 10-ft centers were placed through the forms prior to grouting. In addition to the row of holes at the crown, an additional row was placed on each side 4 ft above the springing line, and another row along the bottom of the steel liners. All holes through the steel liners were on 8-ft centers. Table II gives the quantities of grout used in the various sections.

TABLE II. QUANTITIES OF GROUT USED BEHIND TUNNEL LINING

| Type of Lining | Length Lin Ft | Grout in Cu Ft per Lin Ft of Tunnel: Low Pressure | High Pressure |
|---|---|---|---|
| Concrete | 33,691 | 1.50 | 0.42 |
| Steel | 2,044 | 10.00 | .. |
| Timbered area | 504 | 12.85 | 1.51 |
| Total cement grout used | | | 92,439 cu ft |
| Average per lin ft of tunnel | | | 2.55 cu ft |

The cost of the drilling was about 86 cents per lin ft of tunnel. Grouting cost about $1.93 per cu ft.

## COST FIGURES

In estimating the cost of the tunnel concrete, the total net cost of each of the various plants (mixing, tunnel, forms, etc.) was charged off against the total output or production of the plant. Table III gives the total and unit costs of tunnel concreting plant. Since all the plant has not been salvaged, the net cost represents the first cost less estimated salvage. Costs include equipment, material, and labor.

The depreciation costs shown in Table IV were computed by adding together the appropriate plant depreciation charges from Table III. Thus, to obtain the total plant depreciation charge on the concrete for the arch, mixed at the dam plant, add $1.00, $1.14, $0.40 and $.05 to get $2.59. Table V gives costs per cubic yard.

TABLE III. TUNNEL-PLANT COSTS AND DEPRECIATION PER UNIT OF PRODUCTION

| Location and Description | Net Cost | Plant Production | Depreciation per Cu Yd Concrete | |
|---|---|---|---|---|
| Dam plant: | | | | |
| Aggregate handling | $186,600 | 522,000 tons | 0.61 | |
| Cement handling | 37,100 | 336,600 bbl | 0.12 | |
| Mixer plant | 81,800 | 302,000 cu yd | 0.27 | 1.00 |
| | $305,500 | | | |
| McFarland plant: | | | | |
| Aggregate handling | $112,000 | 174,000 tons | 1.01 | |
| Cement handling | 19,500 | 163,000 bbl | 0.18 | |
| Mixer plant | 48,300 | 111,000 cu yd | 0.43 | 1.62 |
| | $179,800 | | | |
| Power-house plant: | | | | |
| Material handling | $ 37,700 | 51,500 tons | 1.16 | |
| Mixer plant | 11,500 | 32,600 cu yd | 0.35 | 1.51 |
| | $ 49,200 | | | |
| Tunnel plant: | | | | |
| Track material | $ 86,000 | *846,300 cu yd | 0.10 | |
| Track work | 50,000 | 199,300 cu yd | 0.25 | |
| Agitator cars | 72,300 | 199,300 cu yd | 0.37 | |
| Placers and screeds | 22,000 | 199,300 cu yd | 0.11 | |
| Bridges and platforms | 54,400 | 199,300 cu yd | 0.27 | |
| Special trestle | 7,600 | 199,300 cu yd | 0.04 | 1.14 |
| | $292,300 | | | |
| Tunnel forms: | | | | |
| Invert | $ 7,000 | 36,800 cu yd | 0.19 | |
| Arch | $ 50,000 | 126,400 cu yd | 0.40 | 0.59 |
| Other plant: | | | | |
| Vibrators, tools, etc. | $ 22,000 | 437,600 cu yd | | 0.05 |

* This quantity includes about 650,000 cu yd of tunnel excavation for which the track material was also used.

TABLE IV. PLANT DEPRECIATION SCHEDULE FOR TUNNEL CONCRETE, INCLUDING COST OF FORMS

| Kind of Concrete | Location of Mixing Plant: Dam | McFarland | Power House |
|---|---|---|---|
| Curb | $2.19 | $2.81 | $2.70 |
| Invert | 2.38 | 3.00 | 2.89 |
| Arch | 2.59 | 3.21 | 3.10 |
| Other | 2.19 | 2.81 | 2.70 |

Construction of the Apalachia Project was inaugurated while the late Theodore B. Parker, M. Am. Soc. C.E., was Chief Engineer of the TVA. He was succeeded on July 1, 1943, by C. E. Blee, M. Am. Soc. C.E., A. L. Pauls, M. Am. Soc. C.E., was Chief Construction Engineer. At the job, Charles P. Wright, M. Am. Soc. C.E.,

TABLE V. DETAILED COST OF TUNNEL CONCRETE PER CU YD

| Operations | Curb | Invert | Arch | Other |
|---|---|---|---|---|
| Concreting: | | | | |
| Aggregates, $1.72 per ton at mixer | $ 2.73 | $ 2.77 | $ 2.65 | $ 2.97 |
| Cement, $2.10 per bbl at mixer | 2.90 | 2.83 | 3.18 | 3.41 |
| Mixing | .41 | .42 | .41 | 1.04 |
| Transporting | 1.43 | 1.44 | 1.43 | 1.43 |
| Placing, vibrating, curing, finishing | 1.65 | 1.21 | 1.08 | 1.59 |
| | $ 9.12 | $ 8.67 | $ 8.75 | $10.44 |
| Form work, steel and wood (labor, material, depreciation) | $ 5.76 | $ 1.10 | $ 1.24 | $ 2.59 |
| Plant depreciation, less forms | 2.54 | 2.54 | 2.55 | 2.57 |
| Construction facilities | 4.35 | 3.08 | 3.13 | 3.98 |
| Total cost per cu yd | $21.77 | $15.59 | $15.67 | $19.58 |
| Cu yd per lin ft of tunnel | 0.67 | 1.09 | 3.76 | |
| Total cost per lin ft of tunnel | $14.50 | $16.82 | $58.92 | |

was Construction Engineer; T. L. Brown was Construction Superintendent, succeeded on June 1, 1942, by R. V. Sass; and G. W. Foster was Tunnel Superintendent, succeeded on May 1, 1942, by D. F. Simpson. Tunnel concrete was largely completed by Messrs. Sass and Simpson.

# Employers' Needs Evaluated by Questionnaire

*Accuracy Considered Prime Attribute by Employers as Shown by Northern Montana College Study*

*By* F. W. Pearce, Assoc. M. Am. Soc. C.E.
Head of Engineering, Northern Montana College, Havre, Mont.

As a guide to planning the curriculum and objectives of an engineering college, a study was made recently by Northern Montana College. Questionnaires were sent to members of civil engineering firms, highway engineering departments, railroads, city and governmental departments. Considerable interest was evidenced by the large number of replies to the questionnaires and also by the many additional comments that were sent in.

A compilation of answers to the questionnaire is given in Table I, which is divided into five parts, corresponding to Questions 1 to 5 of the questionnaire. In addition, opportunity was given to make specific recommendations and comments. It was from these comments that some very helpful suggestions were gleaned. For instance one city engineer stated, "What is needed in an engineering graduate is aptitude and training to develop beyond the sub-professional status."

### Comments from Members of Engineering Firms

Here are a few comments from members of engineering firms: "Character, ability, and personality are top essentials. Help the young engineer to develop ingenuity, resourcefulness, and the ability to logically follow a problem through from preliminary inception to a workable solution. Too many men always require direction. Discussion of ethical procedure, the relations with contractors, the public, and fellow engineers are helpful to young men and are reflected in later years. . . . To get along one must develop personality and command the respect and cooperation of others. Few if any, get to the top solely as a result of their own ability or efforts."

"The student should be made to realize that good surveys are essential to good engineering planning. An engineer cannot serve his client unless he can plan the survey that will best serve the purpose for which the survey is being made and execute it economically. Every survey is different, and specifications covering the survey should be written before the survey is commenced."

Another stated: "An engineer should be an educated man. Technical training may make a good technician, but not a good engineer or an effective citizen. Engineering education should be part of an all-round education, not an alternative to it."

The next two quotations illustrate two different ways of saying the same thing: "Most engineers think they must be hard boiled. True—they must be positive, firm—but too many of them associate these characteristics with high-top boots, a chew of tobacco, cheap whisky, poor grammar, and an expressed hatred of culture."

"Engineers should be trained to feel at home in groups of people, be well mannered, and be able to conduct themselves with perfect ease socially."

Another member of an engineering firm wrote: "We have had at least 200 different engineers in our employ. One of the most striking faults that I have discovered among engineers is their inability to prepare engineering reports and to use properly the English language. I think our engineering schools all over the country are falling short in these two requirements."

"In our work, one of the essential duties has been the preparation of engineering reports of irrigation projects. Out of the many engineers who have been in our employ, I do not think that we have had more than four or five who are really trained to put their work on paper in a concise, orderly, and complete manner.

"One thing I have noticed so much among engineers in our work is their inability to coordinate the field information to be obtained with the use that is to be made of that information when it comes into the office. We have found that accuracy and neatness are very essential for field men."

### Surveying Needs Explained

Certain engineers of state highway departments expressed themselves as follows: "It might be a good idea if some engineers with considerable experience could be induced to give some lectures to the students while they are engaged in field work, as the ordinary college professor is generally lacking in practical details."

"Greater stress should be placed on coordination of the various individual subjects to enable the student to visualize a complete problem, break it down into the essential components, and understand the relationship and importance of each. . . . In emphasizing accuracy, care must be taken to avoid losing sight of the general picture by getting lost in details."

"I think it sound that colleges stress the 'why' of engineering principles, as they have been doing. Except for the matter of technique (which can be developed by practice) the principal shortcoming of the graduate is within himself. Habits of working diligently, putting job ahead of pleasure, and habits which create the feeling in his employer that he is entirely reliable, are forces of personality which should be cultivated by each student."

### Other Fields Heard From

Several chief engineers of American railroads replied. One said: "It is unfortunate that, with the growth of highway and other means of transportation in the last two decades, there has been a tendency on the part of colleges and universities to give less and less attention to the study of railroad engineering and operating problems."

Another added: "I think the important function of the engineering school is to provide a broad technical background whereby the principles involved in the many specified problems of engineering practice will be understood, and will serve as a sound basis for later research, development and application."

And still another wrote: "Most of the graduates from the well-established universities today are desirable if they have the human qualities of honesty, integrity, pleasing personality, ability to get along with people, power of leadership, determination, and willingness to give the best they have to their jobs."

One United States Government official stated: "This office is gradually changing its mapping methods to take full advantage of the benefits that are derived from the use of aerial photographs. It is now equipped with a very large number of multiple mapping instruments, and it is probable that in the future even greater numbers will be secured. The application of this method in the civil engineering field indicates the desirability of having engineering colleges give sufficient instruction in the use of photogrammetric methods to make the students aware of the great part that these methods will play in the future and thus avoid the surprise that will come to them after graduation when they learn that the entire subject is one on which they have had no instruction in college. It is not felt that the colleges can give thorough instruction in these methods, but it is believed that they should be aware of the situation and do what is possible to apprise the students of the change that is taking place."

TABLE I. COMPILATION OF RESULTS OF QUESTIONNAIRE TO ENGINEERING EMPLOYERS

I. SURVEYING OPERATIONS CARRIED OUT BY THE ORGANIZATION

| Surveying Operations Carried Out by the Organization | Occurrence | Order of Occurrence | Use |
|---|---|---|---|
| Grade stakes | Frequent | 1st | Cities, eng. firms, railroads, highway depts., and U.S. Gov. depts. |
| Profiles | Frequent | 2nd | |
| Alinement | Frequent | 3rd | |
| Cross sections | Frequent | 4th | |
| Vertical curves | Frequent | 5th | |
| Circular curves | Frequent | 6th | |
| Property surveys | Occasional | 7th | |
| Slope stakes | Occasional | 8th | |
| Topographic surveys | Occasional | 9th | |
| Traverses | Occasional | 10th | |
| Instrument adjustments | Occasional | 11th | |
| Stadia | Occasional | 12th | |
| Triangulation | Rare | 13th | Eng. firms, cities, highway depts., and U.S. Gov. |
| Spirals | Rare | 14th | Railroads and highways |
| Solar determinations | Rare | 15th | Highways |
| Polaris determinations | Rare | 16th | Highways |

II. The following titles were given as those considered most appropriate for the average civil engineering graduate engaged primarily in surveying.

| Title | Occurrence | Order of Occurrence |
|---|---|---|
| Junior Engineer | Frequent | 1st |
| Instrument Man | Frequent | 2nd |
| Rodman | Frequent | 3rd |
| Chief of Party | Occasional | 4th |
| Assistant Engineer | Occasional | 5th |
| Chainman or tapeman | Occasional | 6th |

Others mentioned but much in the minority were engineer-surveyor, computer, surveyor, transitman, level man, field engineer, and locating engineer.

III. Desired attributes as arranged by employers in order of importance:

| Attribute | Rank | Attribute | Rank |
|---|---|---|---|
| Accurate | 1 | Energetic | 6 |
| Reliable | 2 | Foresighted | 7 |
| Thorough | 3 | Judicious | 8 |
| Having initiative | 4 | Methodical | 9 |
| Resourceful | 5 | Considerate of employer | 9 |
| | | Respected | 10 |

Others mentioned but much in the minority were loyal, honest, diplomatic, courageous, and having high ideals.

IV. SHORTCOMINGS IN ENG. GRADUATES

| Shortcomings in Eng. Graduates | Occurrence | Order of Occurrence |
|---|---|---|
| Have little conception of work to be done | Frequent | 1st |
| Lack initiative | Frequent | 2nd |
| Lack confidence | Frequent | 3rd |
| Inability to use good English | Frequent | 4th |
| Have difficulty in following written instructions | Occasional | 5th |
| Are not cooperative | Occasional | 6th |
| Poor mathematical background | Occasional | 7th |

Others mentioned but much in the minority were lack of public relationship or salesmanship, conceit, overconfidence.

V. PRINCIPAL SHORTCOMINGS IN ENG. TRAINING

| Principal Shortcomings in Eng. Training | Occurrence | Order of Occurrence |
|---|---|---|
| Thoroughness not given proper emphasis | Frequent | 1st |
| Good technique in field work not stressed | Frequent | 2nd |
| Good lettering not sufficiently encouraged | Frequent | 3rd |
| Inaccuracy not curbed | Frequent | 4th |
| Unsystematic methods of working evident | Frequent | 5th |
| Mathematical computations not reliable | Occasional | 6th |

### OPINIONS SUMMARIZED

Summarizing the comments offered, it is apparent that employers consider the following improvements to college training essential:

Higher prerequisites for admission should prevail, with more careful selection of students. The period of training should be increased to five years, during which time the general objective should be to train for leadership. Originality and resourcefulness should be encouraged because these attributes, along with perspective and energy, are essential. Accuracy, thoroughness, and neatness should be drilled into students. Greater confidence in ability should be instilled with accent on training in how to find needed information and to use it properly. Memorizing is then relatively unimportant.

During college, intensive and thorough training should be given in basic sciences—mathematics, chemistry, physics, and mechanics. Civil engineering students should have thorough courses in concrete and steel design, railroad engineering, construction procedure, and specification writing, while all engineers should develop normal skills in drawing and manual arts courses. Skill in reading and interpreting engineering drawings is fundamental. No instructor should be permitted to load his particular courses to the point that proper time cannot be given to other equally important courses.

In general more attention should be given to surveying. Courses should be made as practical, thorough, and comprehensive as possible. Instrument care, the study of errors, preparation of field notes and specifications for surveys should be covered; and land, construction, and photogrammetric surveys should be taught both in courses on campus and at surveying camps.

### INCLUSION OF CULTURAL COURSES

An engineer is something more than a technician. Therefore, it was recommended by many employers that cultural courses be included in the curriculum. More emphasis should be placed on English, public speaking, and composition, including report writing. There should be courses in logic, economics, finance, government, history, geology, biology, sociology, and law. A seminar or orientation class should discuss such topics as job interviews, supervision of men, ethics, character, public relations, licensing and professional development after college.

Class work can be made more practical by having practicing engineers lecture in coordination with assigned problems similar to those encountered in practice. Instructors should have a background of practical engineering experience. Consideration should also be given to the use of training films and training devices similar to those adopted by the armed forces and proved to be very instructive.

Many of the men who have been most successful are most insistent that students realize that real training begins when one leaves school. Men should be encouraged to undertake postgraduate studies, read technical publications, and develop a professional attitude. Civil engineers would fare better if they would take a more tolerant attitude toward refinement and culture and extend their influence in community, social, and professional organizations.

# Getting the Most Out of Sewage Works Data

*By* William L. Havens *and* Frank Woodbury Jones
Members Am. Soc. C.E.; Partners, Havens and Emerson, Consulting Engineers, Cleveland, Ohio

*Frequently a study of reports from a sewage treatment plant reveals omissions and discrepancies which make it difficult to draw useful conclusions. In this paper the authors appeal for greater care in the accumulation of data, to the end that the information may be utilized more effectively. The examples given and the incidents cited are actual cases. This article is a condensation of a paper presented before the annual meeting of the Sanitary Engineering Division.*

Typical Activated-Sludge Type Treatment Works Operated by the City of Elyria, Ohio

Sewage works data should be obtained, recorded, preserved, and examined frequently for three chief purposes:

1. To serve as evidence of past performances.
2. To show current accomplishments as regards adequacy, economy, and effectiveness of the treatment processes.
3. To determine the need for extensions and improvements, and to provide a sound basis for the design of such betterments.

It is obvious that, to be of real value, all data must be reliable and capable of standing up under a critical examination. Otherwise the deductions made from them will not be dependable, or suitable for any purpose—whether to defend past achievement, to appraise present accomplishment, or to design for future needs. Such information may be expressed and recorded in various and sundry ways, but basically the following data should be available:

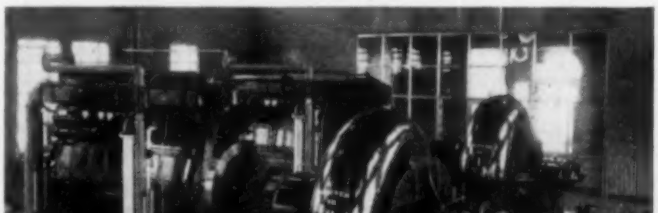
1. The number of persons served, and the tributary area in acres
2. The volume of sewage, in million gallons per day
3. Chemical analyses showing sewage constituents, in parts per million
4. Volumetric measurements and analyses of screenings, grit, sludges, and by-products expressed in cubic feet, per cent, or other definitely stated unit
5. Bacterial analyses
6. Cost data as total expenditures allocated to capital expenditures, and to cost of operation and maintenance, divided as to labor and material.

The chemical analyses should include, as usually expressed, total solids (total, fixed, and volatile); suspended solids (total, fixed, and volatile); and 5-day biochemical oxygen demand. Others appropriate to the problem at hand should be included, such as nitrogen in its various forms (total, organic, nitrite and nitrate); oxygen consumed; iron (total and ferrous); alkalinity or acidity; sulfates; chloride chlorine; residual chlorine; and ether-soluble matter. Bacterial analyses can ordinarily be confined to total bacteria per milliliter and presumptive tests for gas formers in several dilutions.

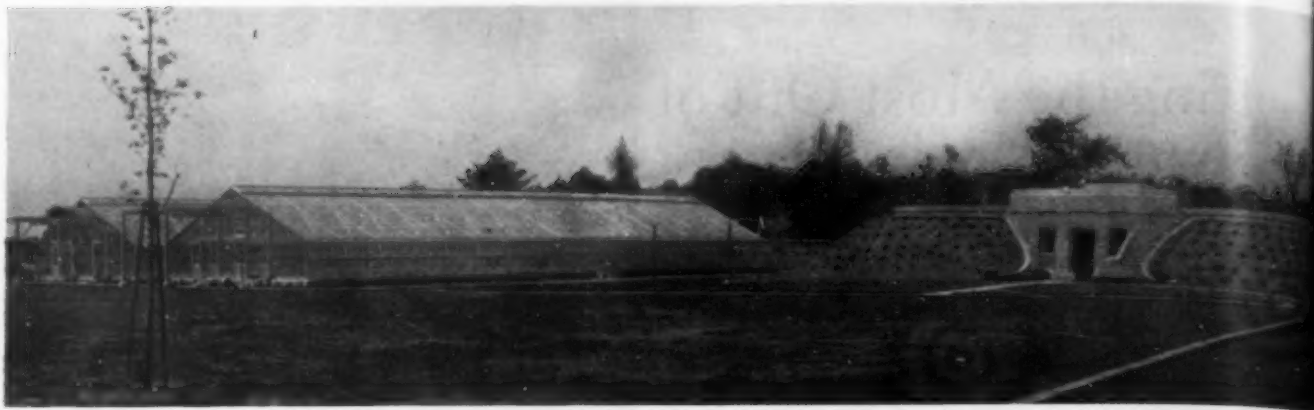
For complete information and effective evaluation, the analyses should be made on the raw sewage as received, and on the effluents from progressive major treatment processes. Analyses of filtered as well as unfiltered samples give additional and helpful information. Special problems, such as grease recovery and sludge indexes, require detailed investigations as the need arises.

Aside from chemical analyses of the sewage and effluents, quantitative and volumetric measurements and analyses should be made of screenings, grit, skimmings, and sludges, both fresh and digested. Ordinarily a record of total and volatile solids is sufficient. Where digestion is practiced, the data should include quantity and quality of supernatant liquor; alkalinity as $CaCO_3$; volume and composition of gas, reduced to 0 C and 760 mm mercury; and volume of digested sludge. The disposal of sludge on sand beds should be evaluated in pounds of dry solids per square foot per year, or similar unit. Where mechanical filtration and incineration are practiced, there should be full information on all factors involved. In the activated sludge process, volume of returned sludge, concentration of mixed liquor, air used, and sludge wasted, all demand appropriate measurement.

In addition to the quantitative determinations and volumetric measurements, sewage works data should include routine and regular observations and records as to wind and weather; precipitation; temperatures of the atmosphere and of the sewage; appearance of the sewage; odors (if present, defined as to kind and intensity, and if absent, so stated); screenings and grit removals; tank operation; sludge additions and withdrawals; supernatant withdrawals; changes in operating procedures; effect of sewage and gases on buildings and equipment; breakdowns; repairs and maintenance;



400-Hp Gas Engine Drives Blowers at Cleveland Works
Data on Gas Production May Justify Such an Installation



INDIAN ORCHARD TREATMENT WORKS AT SPRINGFIELD, MASS., SHOWING DRYING BEDS (LEFT), SLUD

causes of any failures; costs for operation and maintenance, divided between labor and material; and the many apparently inconsequential matters which when grouped make possible an overall picture. In this connection, plants in cities, of, say, 20,000 or over should have a U.S. Weather Bureau Station; and if they are on a stream, a gage for flow measurements. The more relevant supporting evidence there is, the better the engineering judgment will be.

### MEANS FOR SECURING DATA

Coordinated and reliable data are dependent upon several contributing factors. Of first importance is the personnel, from the humble sampler to the astute superintendent. No chain is stronger than its weakest link, and a weak link anywhere in a chain will limit its ability to withstand the strain of critical examination. Much has been written concerning sampling, yet the fact remains that the most important factor is the sampler.

To illustrate, if the sampler has for his sole objective the taking of a full bottle to the laboratory in the morning, this objective may be and sometimes is attained at any time during the sampling period. Ofttimes too, a lack of appreciation of the importance of sampling results in discordant data, as was the case when a sampler who was faithful to the hourly schedule, but wished to make place for the last few samples, poured off the clear liquid from the top of the bottle—already full and well settled. When this was discovered, the reason for the apparently erratic performance of the tank was at once apparent. It has been found also that samplers favor the heaviest discharges when sampling flowing sludge. This is probably why the amount of fresh solids is usually greater when calculated from sludge samples than when computed from differences in the amount of suspended solids in the raw and in the settled sewage.

Another important link in the chain of information is the laboratory. This link may be weakened by carelessness, or sloppy and inept procedures. Witness the laboratory assistant who constantly misread his balance weights and, which is quite common, made mistakes in simple calculations. A laboratory, even one fully equipped with all the necessary apparatus, becomes of little account if the work is done without a realization of the necessity for careful and correct techniques.

Other elements essential to reliable sewage plant information are the proper meters, thermometers, other measuring devices, and pumps. Meters are used to measure both liquid and gaseous flow and they easily get out of adjustment. They should be verified frequently and a record kept. For the worth-while evaluation of data, it is essential therefore that all the elements concerned in the gathering of the information—whether personal or instrumental—be reliable and in proper working order, and their dependability should be ascertained by test from time to time.

There is no dearth of good instructions and forms listing what data should be obtained, and explaining in what terms and in what manner they should be recorded. Following these guides, there are many excellent annual reports delineating in detail a sequence of happenings and displaying neat arrangements of tables and curves depicting plant performances. Yet a check, even of the best of these reports, will often reveal obvious discrepancies that could have been avoided had the data been carefully examined when received, instead of being put aside until the monthly or annual report.

For example, where secondary treatment is used, there is no reason why the raw sewage meter should not be in accord with the settled sewage meter during dry periods when no by-passing occurs. If some settled sewage is by-passed, and not given secondary treatment, this should be stated, so as to remove an otherwise obvious error in the record. It is surprising, also, how often in sludge digesters the recorded volume of raw sludge added will not balance with the withdrawals of digested sludge and supernatant. In one instance, an inquiry into the difference between the digester input and legitimate withdrawal revealed a surreptitious discharge "to the river," during the night watches.

In other observed instances, it appeared that the record keeping was merely a routine of putting down figures without considering their reasonableness, significance, or reliability. When such records covering a period of years are used to evaluate past performance in terms of design for future requirements, it is difficult to reconcile the conflicting testimony they present.

Sewage plant records are useful in many ways. First, it is always interesting and instructive to compare current performances with those of the past. Where departures occur, the wise operator will determine the cause and seek a remedy, whether it be to change and improve operating procedures or to plan for plant enlargement. Then, too, they afford a check on contributions of unusual character to the sewerage system.

Another item of considerable concern, and one on which there are few correlated data, is the relative amount of bulk or sludge solids coming from the domestic population, from industrial wastes, and from storm water. These quantities may be determined in many cases if the plant superintendent approaches the problem with a view to securing the necessary information over a period of time. Such information will naturally increase in value the longer the period for which data are available.

STION WORKS (CENTER), AND CONTROL HOUSE (RIGHT)

To yield the best information, sewage analyses should be made daily. This can be done quite acceptably from 24-hour composites made up from hourly samples in proportion to flow. Catch samples or samples taken at relatively long intervals are not reliable. A composite sample usually tells a true story, although occasionally slugs of industrial waste, even of short duration, will be of such character as to dominate the whole day's composite. While it would be ideal to analyze hourly samples and make weighted averages of them, the reliability of analyses of composite samples, particularly as regards solids, has been demonstrated in a number of investigations.

Every plane survey to be reliable must close. By the same token, sewage works analyses should permit of evaluation to effect a reasonable balance between input and output.

The bulk or sludge-producing solids are still the major problem in practically every sewage plant. There are too many overloaded and ineffective sludge-handling facilities. This condition could be avoided if due care were taken to anticipate the solids production. As stated previously, it is usually found that the quantity of sludge solids computed from differences in suspended solids is much less than that found from samples of the recovered sludge. In this connection, and because of possible sludge-producing reactions which might occur in settling tanks, the recent trend is to use determinations of total solids in sewage and effluent for calculating sludge quantities. If determinations of both suspended and total solids are used, and if the departures are all in one direction, positive conclusions concerning changes in the state of the solids may be drawn. On the other hand, lack of care in sampling and other procedures, and failure to evaluate the data as received, are more to blame for discrepancies than is the basic principle involved.

Where sludge digestion is practiced, the solids balances are notoriously discordant. A 50% discrepancy is not unusual, and practically always it is in the wrong direction; that is, almost invariably there is more digested sludge to handle than was anticipated. Here again, persistence and scrutiny all along the line will make for more reasonable conclusions.

Some years ago, one of the authors attempted to establish the capacity of sludge-drying sand beds. The reports usually catalogued the number of fillings and cleanings, and the volume and percentage of moisture, but they gave no indication as to whether the dried sludge was removed as soon as possible, or whether the beds stood idle for a period between cleaning and refilling. Considerable other data were lacking, which if included would have rounded out the story sufficiently to permit definite evaluation in terms suitable for design. The drying capacity, expressed in pounds of dry solids per square foot of sand area per year, was found to vary greatly, but from the records it was difficult to determine whether the cause of this was to be found in the condition and density of the sludge, in the weather, the depth on the bed, the design, or the operator's procrastination. Certainly it should be possible to record a process as simple as sludge drying on sand beds in such a way as to provide information both definite and reliable.

Much has been written regarding costs of operation, but to say the least some figures are confusing. An operator who uses prison or relief labor for much of his plant work, but who regards this as "free" and hence does not include it when making up his costs, is not stating the facts. All work, both for labor and for material utilized in operation and maintenance, should be given a value appropriate to the prevailing prices in the locality. Then, too, it should be clearly stated whether or not capital expenditures are taken into account. Cost per capita served appears to be a better basis for public information than cost per million gallons treated. The point to be emphasized, however, is that all facts and factors should be stated. Then the reader can convert them to any unit desired and reach his own conclusions.

Sewage plant records should be made, maintained, and preserved in as great detail as possible, but they are of no account unless they are utilized effectively. The greatest need, as judged by a study of many reports, is more attention to checks and closures to permit reasonable, dependable evaluation in any terms desired.

SLUDGE FILTERS AND INCINERATORS AT CLEVELAND WORKS
The Capacity of This Installation Was Determined by Careful Analysis of Records

The methods of analysis and computation currently in use can be made to yield reliable information provided that plant personnel take due care to see that samples are representative, that laboratory work is accurate, and that all measuring devices and plant equipment are in correct adjustment for the purposes intended.

There is no point in amassing voluminous data unless they present a true story of past trends, present accomplishment, and probable future performance. The future can be predicted only by studying past and present performances, interpreting trends, and tempering all with experience and judgment. When all elements have been coordinated and evaluated, the conclusion should represent the best possible answer.

# Peculiarities of Aleutian Military Design

*By* Joseph D. Bodman, Jun. Am. Soc. C.E.
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*The Aleutian Islands were the closest land masses to Japan that the United States controlled before the war. Japanese plans called for early occupancy of these thinly peopled, treeless islands. And they would have succeeded had not their commanders been frustrated by the military planning and operations of the Alaska Defense Command and the engineering and construction prowess of supporting agencies—such as the Seattle District Office of the U.S. Army Engineers, which was charged with the preparation of engineering designs. Mr. Bodman's article outlines some of the engineering problems encountered in this little known part of the world, and their solution.*

In June 1942 the Japanese attacked Dutch Harbor and were repulsed largely because of the existence of a then-secret air base on Umnak Island. After this rebuff they established themselves on other Aleutian Islands to the west—principally Kiska and Attu.

The existence of the secret air base was due to the foresight and energetic action of the Alaska Defense Command, combined with long hours of hard work by supporting units in conquering engineering and supply problems. The Seattle District Office of the U.S. Army Engineers, as one of these supporting units, played a major role in the establishment of the base on Umnak Island as well as succeeding bases, which eventually resulted in the elimination of the Japanese from the Aleutians and enabled offensive action to be taken against the Kuril Islands.

### DESIGN STARTS FROM SCRATCH

In designing facilities for the Aleutian bases, interesting and perplexing difficulties were encountered, which called for every trick in the engineer's bag. Design was required for such diverse structures as wharves, seaplane ramps, gasoline systems, hangars, warehouses, shops, sea-coast fortifications, submarine pipe lines, utilities, and an endless list of such facilities as barracks, mess halls, and hospitals. To further complicate the situation, use of critical materials was restricted and plans were required to utilize the materials available.

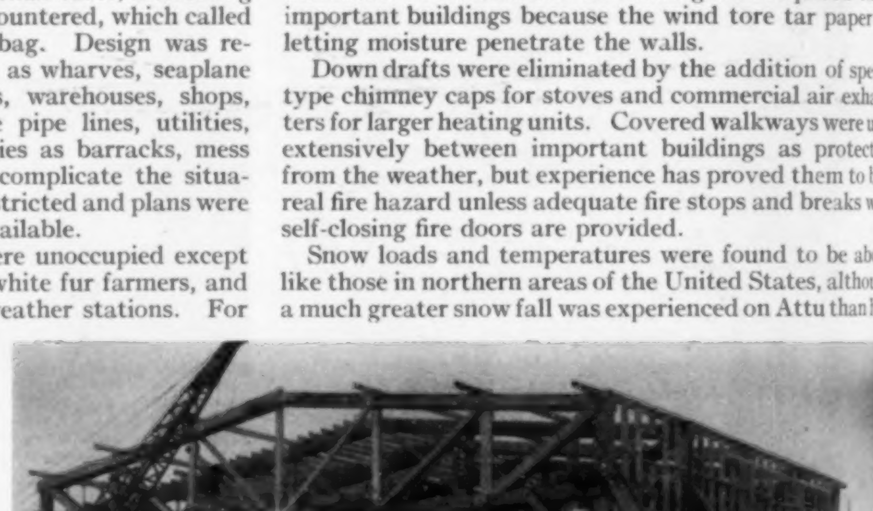
Most of the Aleutian Islands were unoccupied except for occasional native settlements, white fur farmers, and the personnel of a few scattered weather stations. For this reason information on conditions was very scanty at the start of the war, and much was left to the designer's imagination. To cite a few instances, foundation conditions were rarely known; accurate topographic maps were not available; the presence or extent of teredo action was indeterminate; and knowledge of weather and wave conditions was very limited. Difficulty of communicating with the projects further restricted the flow of information, as it was necessary to encode all radiograms and take special precautions with letters to keep data from the enemy. In addition, speed was the essence of the construction program, and it was therefore impractical to make proper site investigations.

This situation naturally led to the development of so-called "typical drawings," which served as a basis for procurement and a guide in construction. The typical drawings made in the Seattle District Office are usually modified somewhat in the field to suit actual conditions, but care is taken to minimize changes affecting key points in the design. Approximately 500 of these sets of typical plans have been prepared for buildings, docks, gasoline, water, and electrical utilities, as well as hundreds of drawings for specific installations at definite projects.

It was found that the "unusual" weather was one of the major factors affecting design. Winds with an intensity of 100 mph were common and they quickly leveled buildings of conventional construction. They also caused serious downdrafts in chimneys protected by the cone-type caps, and several fires were started from this source. Correction for wind was achieved by additional wind bracing, diagonal sheathing, decreasing the distance between the studs, and increasing the size of the structural members. It was found that siding was required on all important buildings because the wind tore tar paper off, letting moisture penetrate the walls.

Down drafts were eliminated by the addition of special type chimney caps for stoves and commercial air exhausters for larger heating units. Covered walkways were used extensively between important buildings as protection from the weather, but experience has proved them to be a real fire hazard unless adequate fire stops and breaks with self-closing fire doors are provided.

Snow loads and temperatures were found to be about like those in northern areas of the United States, although a much greater snow fall was experienced on Attu than had



Erecting Hangar for Small Fighter Plane. Note Exterior Struts to Provide Extra Wind Bracing

been indicated by weather records. Because of the prevailing high humidity, special care was taken to form vapor barriers capable of preventing damage to insulation and building interiors. Storm entrances were found to be essential on all buildings used for housing people or for offices. No lightning or thunder storms have been observed there, and protection from such damage is therefore unnecessary.

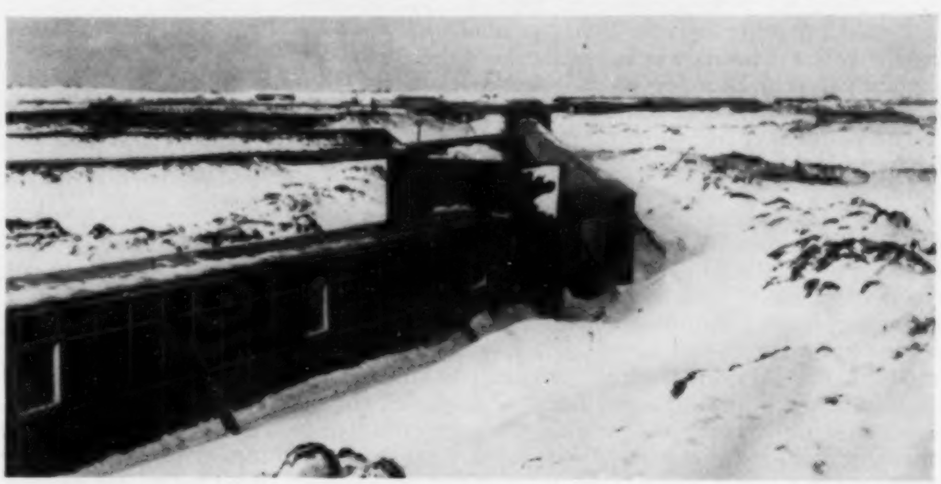
Action of the waves was found to be much worse than had been anticipated, and in some instances their power is of almost inconceivable magnitude. At Shemya a 2,000-ft section of rubble breakwater, constructed across the path of the waves, was completely destroyed and the material, including huge rocks weighing several tons, was hurled back onto the beach. In the same storm one observer reported seeing sections of steel landing mat, which had been laid to protect the breakwater slopes, actually being tossed along the tops of the boiling waves. In some instances, 50-ft deck sections of wharf were lifted completely off their supporting piles by waves rising from underneath, sometimes pulling or breaking the piling as they were torn away.

At one such location a 60 by 300-ft cellular sheet steel dock filled with rock and with a concrete plug in the bottom is being constructed. The dock axis is perpendicular to the waves, and the outer end cell will be completely filled with concrete. The dock height is 22 ft above mean lower low water, or above the crest of most of the highest waves. Although such a height makes the unloading of vessels inconvenient, it obviates the necessity of removing equipment at the approach of each storm. Docks at more sheltered locations have followed conventional wood pile-and-cap design except that heavier bracing has been provided and piling is untreated. Although no teredo action has been reported in the Aleutians to date, it is still possible that it will be found, as the roving nature of the borer is well known.

Experience gained in stripping grass and tundra from

Dock and LST Landing Ramp at Shemya, Aleutian Islands
Heavy Seas Destroyed Massive Breakwater Extending Out from Hill at Right

Typical Creek at Umnak Island. Note Vegetation and Lack of Trees



Covered Hospital Walkway on Amchitka, Showing Fire Stop and Exterior Wind Bracing
Tar Paper with Battens Is Not Satisfactory as Siding, Being More Easily Damaged by Strong Aleutian Winds

THIS BUILDING ON ATTU FILLED WITH SNOW AFTER THE ROOF WAS ON

large areas has again proved that it is impossible to upset nature's balance without causing definite reactions. Once the protective mat of vegetation was removed, the underlying soil dried rapidly and was eroded by high winds. The resulting dust caused damage to airplane motors and instruments and was a nuisance to the personnel as well. Special measures have been taken to reduce erosion, such as sand-bagging fills or protecting them with gasoline drums filled with sand. A program is now under way to plant suitable grasses and to re-sod stripped areas in so far as is possible.

### FOUNDATION CONDITIONS VARIED

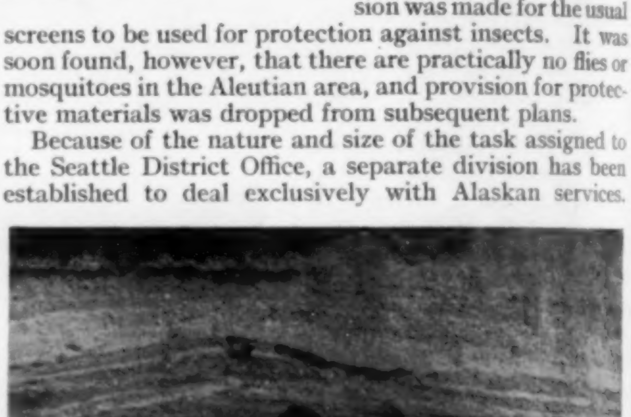
Foundation conditions on the islands vary from solid rock to deep tundra and muck beds incapable of sustaining any appreciable load. In unstable areas, pile foundations are used extensively for all types of buildings, from small 8-man barracks to 180 by 400-ft warehouses and shops. Large deposits of volcanic ash were discovered on Umnak Island and were used to construct good foundations for the runway area. When rolled, these cinders form a tight interlocked surface with excellent drainage characteristics. Similar deposits have been discovered and used on other islands. No "permafrost" (permanently frozen ground) was encountered in the Aleutians, as might have been expected on volcanic islands of comparatively small size and moderately cold temperatures.

The problem of fuel for equipment, stoves, and steam-heating plants was another item of considerable magnitude. Diesel oil was chosen because of its ease in handling and also because it could be used in tractors, trucks, and other motorized heavy equipment. Large storage farms and distribution systems are a necessity because of the inaccessible locations of the projects. To save critical material, an attempt was made to utilize wood-stave tanks for storage of fuel oil. But it developed that while such tanks could be successfully erected by skilled crews, they were not practical when built by unskilled troops. Also, difficult shipping and storage conditions resulted in crushing and loss of staves. Consequently oil storage is now confined almost exclusively to welded or bolted steel tanks.

Good, potable water is readily available on all the larger islands either from streams or lakes. On the smaller ones, however, the supply is limited to wells, infiltration chambers, and small lakes, and every possible means must be taken to utilize the maximum amount of rainfall. In extreme cases, fresh water is used only for drinking and sanitary purposes, and salt water is pumped from the ocean for fire fighting and sewage-disposal systems. Water-borne sewage is a necessity in a limited area in order to prevent ground-water pollution. Construction activities around lakes are held to a minimum to cut down their turbidity.

When the first bases had been planned and the materials procured, provision was made for the usual screens to be used for protection against insects. It was soon found, however, that there are practically no flies or mosquitoes in the Aleutian area, and provision for protective materials was dropped from subsequent plans.

Because of the nature and size of the task assigned to the Seattle District Office, a separate division has been established to deal exclusively with Alaskan services.



VOLCANIC CINDER DEPOSIT ON UMNAK ISLAND
This Material, Properly Compacted, Makes Excellent Surfacing

The members of this division have labored long hours overtime in prosecuting design work and engineering studies, even though early in the war such extra work was done on the employee's own time with no monetary compensation. Difficulties caused by scarcity of critical materials, lack of information, and loss of personnel to the armed forces and other defense agencies, combined with the urgent need for speed, were overcome by bull-dog determination and hard work in the best tradition of the American spirit.

# Model Tests of Portable Breakwaters for D-Day Invasion Harbors

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*Model tests were conducted in a hydraulics laboratory of the Corps of Engineers, U.S. Army, in connection with the planning of the portable harbors used during and after the invasion of France. The tests described by Mr. Hudson were performed in a large wave tank at the U.S. Waterways Experiment Station at Vicksburg, Miss., using small-scale models of a concrete caisson similar to those used to form the D-Day harbors. These tests consisted in the measuring of pressures resulting on the caissons due to model waves which reproduced to scale prototype waves of storm intensity. Investigated also was the ability of the caissons to withstand storm waves without sliding, overturning, or settling.*

Design of permanent breakwaters of the vertical-walled or rubble-mound type, which are to be used to reduce wave action in harbors situated on open coasts, unprotected from the direct onslaught of the ocean swell, is an undertaking not usually relished by the designing engineer. Even today, at a time when most structures can be planned with the assurance that sound scientific principles of design and engineering practice are available, and that calculable safety factors can be established, it is still necessary to design breakwaters which are to be exposed to the open sea almost completely on the basis of lessons learned by experience.

This situation is not due to a lack of ability on the part of designing engineers, who, with help from the mathematician, the physicist, and the research and experimental laboratories, are capable of designing, safely and economically, practically any structure to withstand forces the nature of which can be readily discerned. The reason no such scientific and economical design can be obtained for open-sea breakwaters is that the magnitude, location, and frequency of occurrence of the forces acting on this type of breakwater cannot be calculated or predicted with the exactness usually obtained in other fields of engineering.

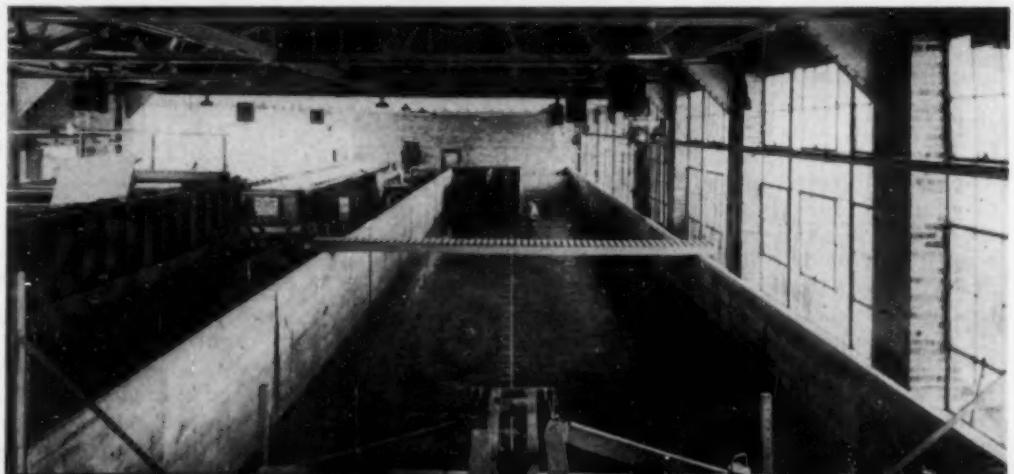
In order to complete the portable harbors in time for use on D-Day, both the British and the U.S. Army and Navy authorities responsible for this phase of the invasion gave high priority to the necessary analysis and design work so that construction of the caissons could be undertaken at the earliest possible date. Another series of model tests, conducted concurrently with those described in this paper, was performed in the laboratory of the Beach Erosion Board near Washington, D.C. The tests made by the Beach Erosion Board were for the purpose of studying the caissons' towing and sinking characteristics.

Of British conception was the plan for using prefabricated portable breakwaters of the caisson type, which could be constructed of concrete in English ports, towed across the channel, floated into position, and sunk end to end to form the required invasion harbors under the very eyes of the enemy. This fact alone should dispel any beliefs previously held as to the conservativeness of the British, at least that of British engineers. For it is impossible to think of a more audacious plan—although admittedly born under the absolute necessity of the war situation—than that of proposing to the Allied High Command the use of portable breakwaters for the protection of ships from the open sea at a time when it was possible for even the slightest of miscalculations to have resulted in disaster to the Allied cause.

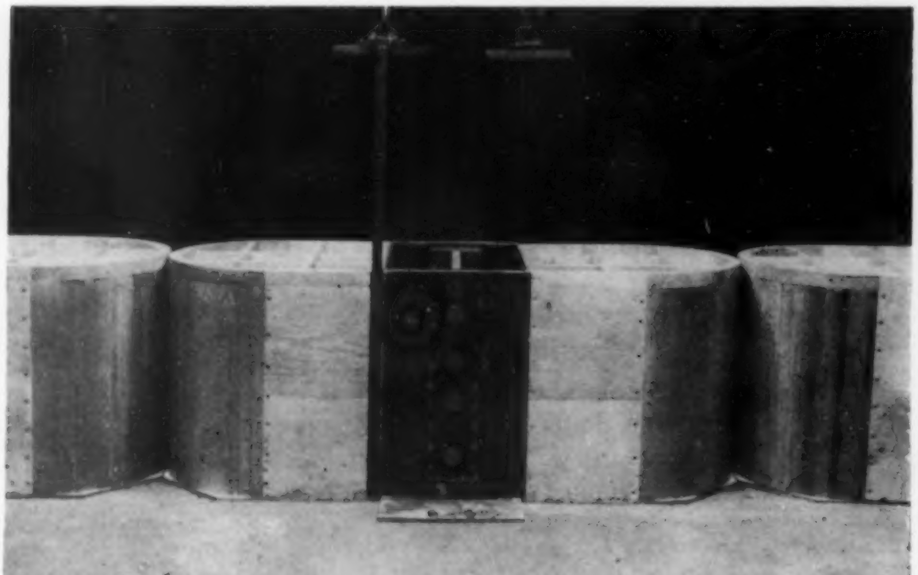
An understanding of the uncertainties involved in the design of permanent-type breakwaters allows us to judge more accurately the degree of daring and faith in their ability which must have been required of the engineers who conceived the idea and drew up the preliminary plans for the use of portable breakwaters on D-Day. Experience in constructing and operating the harbors was reported in Civil Engineering for June by Rear Admiral W. H. Smith, in an article on "Artificial Harbors for Normandy Beaches."

##### Purpose of Model Tests

The uncertainties just referred to made it highly desirable to test the breakwaters as thoroughly as possible before they were used in a game which is always played for keeps. The Chief of Engineers, U.S. Army, Washington, D.C., directed the Experiment Station, therefore, to perform small-scale hydraulic model tests to check the performance of concrete caissons. The purpose of these tests was to help the designing engineers determine the



Wave Tank Used for Model Tests of Caisson Breakwater
Wave Machine Is in Near End of Tank



PRESSURE CELLS WERE ENCASED IN A STEEL SECTION OF THE MODEL CAISSON
Wave-Height Measuring Devices in Place at Each Side of Section

pressures due to waves which the caissons would be called upon to withstand, and to study the characteristics of the caissons with respect to sliding, overturning, and settling. Sunken ships, cellular concrete caissons, and huge steel floats were used to insure sufficient protection to the invasion harbors; however, only the cellular concrete-caisson type of breakwater was tested at the Experiment Station.

### THE MODEL AND ITS PROTOTYPE

The proposed caissons were reproduced using a linear scale ratio of 1 to 30, model to prototype. Two types of caissons, with modifications of each, were tested. However, the open-topped, cellular, concrete-caisson type of breakwater was the one which more nearly reproduced in design the caisson units used at the time of the invasion. Therefore, a description of the other type, and of the results of the tests performed on it, is omitted for the sake of brevity. The model caissons used in the study reproduced, to scale, prototype units consisting of rectangular reinforced-concrete box sections 61 ft high, 60 ft wide, and 100 ft long, with semicircular end sections of 30-ft radii, making an overall length of 160 ft. The thickness of the floor, walls, partitions, and ribs was approximately 1 ft.

The weight of each prototype caisson unit was assumed to be 9,850,000 lb, based on concrete at 150 lb per cu ft. The open top was provided with a 4-ft-wide walkway extending completely around the section. The bottom of the caisson was flat, with a hexagon-shaped footing on the semicircular ends. The interior of each section was divided into 8 compartments by 7 transverse walls extending from bottom to top. Each transverse compartment was subdivided into 4 compartments by 3 longitudinal ribs 5 ft high, measured from the inside bottom. Inlet valve holes were provided in the middle of each compartment on the harbor-side face, with centers about 30 ft above the base of the section.

Prototype wave dimensions were reduced in the model to the same scale ratio as the linear scale ratio of the caissons. Consequently the energy content of the model waves was reduced in the ratio of the cube of the linear scale, or 1 to 27,000. The weight of the model caissons was also reduced using a scale ratio (model to prototype) of 1 to 27,000; each model caisson therefore weighed 365 lb. Other scale ratios, as determined by the application of Froude's model law, were velocity, 1 to 5.48; and time, 1 to 5.48. The velocity and time scales apply to the velocity of wave propagation, wave periods, and pressure-time relations of pressures developed on the breakwater faces by wave impact.

No time scale was established for the scouring of the movable-bed material and the settling of the caissons due to wave action, because it was impossible to obtain the prototype data necessary for the proper adjustment of a movable-bed model. The model caissons were tested in the Experiment Station's wave tank, which was designed especially for tests of this nature. This tank is a concrete structure 5 ft high, 18 ft wide, and 117 ft long, equipped with a plunger-type machine capable of producing waves 1 ft in height. The general features of the tank, with part of the wave machine in the foreground, are shown in an accompanying photograph. Wave pressures on the caissons were measured by a bank of specially developed pressure cells (Fig. 1) and recorded simultaneously with the wave heights and a 60-cycle timing wave on two 7-element oscillographs.

### DESCRIPTION OF TESTS

Pressure tests were conducted on the caisson breakwaters using model waves reproducing to scale prototype waves 12 ft high with wave lengths of 600 ft and 210 ft, at water depths representing high and low tide levels of 53 ft and 30 ft, respectively. For each of these conditions, pressures were measured in the center of a

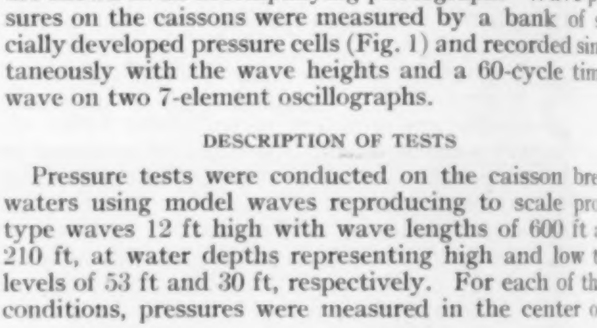



FIG. 1. SECTION THROUGH A PRESSURE CELL DEVISED TO MEASURE WAVE PRESSURES

caisson at five elevations above the breakwater base on both front and back faces. The pressure-measurement tests were conducted using model caissons constructed of wood and bolted rigidly to the floor of the wave tank. The pressure cells were incased in a watertight steel chamber constructed to the same cross section as the caisson.

For the scour (erosion of bed material) tests, in which the sliding, overturning, and settling characteristics of the caissons were investigated, correctly weighed breakwater sections were constructed of plywood incased in sheet metal of the thickness necessary to reproduce the

weight and buoyancy of the prototype sections. Reproducing the prototype weight distribution and wall thicknesses also insured the proper location of the center of gravity, and the simulation of moments of inertia of the prototype structure.

These breakwater sections were placed without restrictions about 75 ft from the plunger end of the wave tank, on a crushed-coal bed material. All scour tests were made with the model caisson sections spaced 4 in. apart (10 ft in the prototype). To obtain uniform compaction, the bed material was molded under water and drained down before each test run. The scour tests were also performed using for study 12 by 600-ft and 12 by 210-ft waves with water levels of 53 ft and 30 ft. Tests were performed with no ballast added to the sections (except water), and with prototype weights of dry sand distributed uniformly in each section of the 6 inner compartments of 2,337,000 lb, 5,948,000 lb, 9,558,000 lb, and 13,179,000 lb. The model weights corresponding to these ballast weights were 86.5 lb, 220 lb, 354 lb, and 487 lb, respectively.

To determine the effect of bottom friction on the sliding characteristics of the caissons, tests were performed with smooth sheet-metal caisson bottoms, and with the caisson bottoms coated with sand. Supplementary friction-coefficient tests showed that the friction developed between sand-coated sheet metal and a crushed-coal bed material was equivalent to the friction developed between moderately rough concrete and sand. As a consequence, the results of the tests in which the caissons' sheet-metal bottoms were coated with sand were given more weight in the analysis of results.

The type of pressure data obtained, and some of the more important results, are shown in Fig. 2, where the pressures (above still-water level hydrostatic pressure) are shown converted to prototype units and compared with the theoretical pressure curve as computed from the Sainflou theory. The Sainflou pressure curve was derived on the assumption that an oscillatory wave is converted into a standing wave (clapotis) at vertical-walled obstructions. Primarily, the pressure tests were performed in order to determine whether the caissons could be designed structurally, using as a basis the pressures calculated by means of the Sainflou formula.

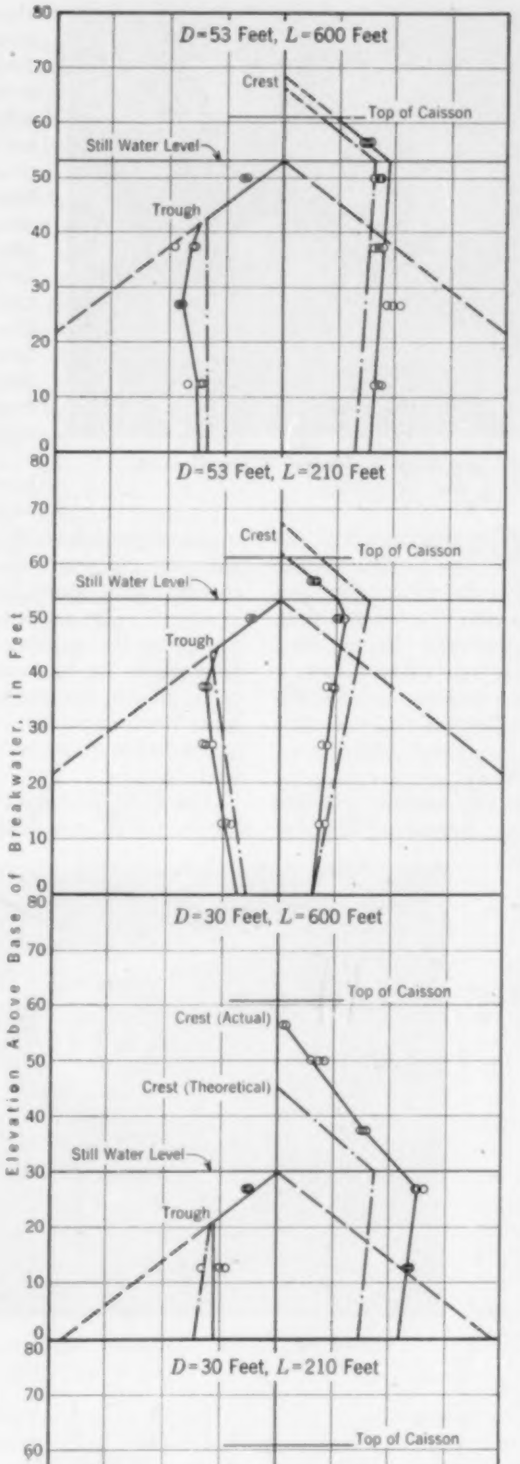



Fig. 2. Pressures on Front Face of Cellular Caisson Breakwaters, as Determined by Model Study

Waves 12 Ft High Were Used in Test

LEGEND

– – – – Hydrostatic Pressure (Still Water Level)

——— Measured Pressures on Breakwater Above or Below Hydrostatic Pressures (Average from Three Separate Observations)

—·—·— Pressure Calculated from Sainflou Theory

$D$ = Water Depth    $L$ = Wave Length

It was found that this formula could be used to calculate the design pressures on the caissons so long as the wave length did not become too great or the water depth too shallow; these latter conditions were found to result in pressures greater than the theoretical. All pressures measured during the course of the investigation were found to be static in nature—no shock-type pressures were recorded. When the caissons were overtopped by the 12-ft high waves, the water fell inside the open top, thereby dissipating the wave energy. Since the effect of wind action can be determined by calculation, its effect on the exposed portion of the caissons was not studied in this investigation.

### Tests of Scour, Settling, Sliding, and Overturning

It was found that the caissons would not overturn when attacked by waves of the largest size used for testing (12 ft by 600 ft). Considerable scouring between the ends of the caissons was found to occur for the larger waves at low tide. However, at no time did scouring of the bed material appear sufficient to cause overturning, although in each instance the model caissons were subjected to wave attack until all erosion ceased. Because of the buoyant forces acting to reduce the effective weight of the caissons as the tide level increased, the 53-ft water depth was the most critical with respect to sliding.

At high tide the caissons did not slide when attacked by waves 12 ft in height if the friction coefficient between the bottom of the caissons and the bed material was as great as that between moderately rough concrete and sand (approximately 0.65). When the

For the Scour Tests, Correctly Weighted Caissons Were Placed on a Crushed-Coal Bed Material

coefficient of friction became appreciably less than 0.65 (as low as 0.4, for instance), the caissons required considerable ballast (sand was used in the model tests) to compensate for the force lost in friction. It was also discovered that considerable ballast was required to prevent the caissons from rocking about their longitudinal axis when a heavy sea was running at high tide. This rocking to and fro was found to result in the slow settling of the caissons into the bed material, thus reducing their efficacy in protecting the harbor from wave action.

In the pressure-measurement tests the caisson sections were placed end to end with no space between, whereas in the scour tests the caissons were placed with their ends spaced 10 ft apart (prototype). It was possible, therefore, by comparing the size of the waves resulting behind the caissons for the two types of tests, to determine the relative degree of protection from wave action that would result in each case. It was found that considerable wave energy was allowed to enter the harbor area when 10-ft spaces were left between the caissons. When the caissons were placed end to end, with no space between, a little wave energy entered the harbor side over the narrow portion of the combined sections caused by the semicircular ends. The effect of the rounded ends was to increase the effective width between the caissons in either case.

At the time these tests were performed, the Experiment Station personnel connected with the investigation were not informed of the use to which the caissons would be put, for reasons of security. However, it was known that the project was in a secret catagory and very important to the war effort in some way. Had there been time, the complete harbor facilities used in the venture could have been tested as a unit to determine the final details of design and the best positions for the different types of obstructions to obtain the maximum protection for a given harbor location. It is possible that tests of this nature were performed by British engineers. Because tests of this kind would have required the reproduction to scale of the entire harbor area to be used for the invasion, they would probably have been performed in complete secrecy by engineers of the armed forces.

The caissons used for the protection of the D-Day harbors were of British design, and therefore were not identical with those used in the model tests described. For instance, the caissons used in this investigation had semicircular ends, whereas those actually used on D-Day were rectangular in plan. The caissons used for the model investigation were of United States design and were (perhaps as a result of the model tests) considerably heavier than those designed by the British. However, had the construction of the caissons been delayed until the complete results of the model studies were available, it is possible that the caissons would not have been completed in time for use on the scheduled invasion date.

The fact that one of the invasion harbors was destroyed by storm does not detract in the least from the soundness and practicability of the project, although it did prove that the caissons should have been made stronger structurally and, perhaps, should have been considerably heavier. The model tests showed that the general plan for using the caissons was sound. Had normal weather prevailed, or had only the maximum storm occurred (that which, from storm frequency curves, might logically have been expected) there would probably have been no appreciable damage to the harbors during their period of usefulness.

The U.S. Waterways Experiment Station, located on a Government reservation four miles south of Vicksburg, Miss., is an agency of the Engineer Department, Corps of Engineers, U.S. Army, and is operated under the jurisdiction of Brig. Gen. Max C. Tyler (M. Am. Soc. C.E.), President, Mississippi River Commission. Gerard H. Matthes (Hon. M. Am. Soc. C.E.), Head Engineer, is Director of the Experiment Station, and Capt. Joseph B. Tiffany, Jr. (M. Am. Soc. C.E.), Corps of Engineers, Executive Assistant to the Director, is Chief of the Hyraulics Division.

Test of Model Caissons with Conditions Approximating Waves of 12 by 210 Ft at Low Tide

Personnel who deserve special credit for their help in the performing of these model tests include Frederick R. Brown, Assoc. M. Am. Soc. C.E., Chief of the Hydrodynamics Branch; Eugene H. Woodman, Electrical Engineer, Chief of the Electrical and Mechanical Section of the Experiment Station; and Robert A. Ford, Associate Engineer, Walter B. Slay, Assistant Engineer, and Francis P. Haues, Junior Engineer.

# A New Structural Shape for Shipbuilding

*By* John P. Fitzgerald, Assoc. M. Am. Soc. C.E.
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To a landlubber trained in the arts and sciences of civil engineering, the realm of the shipbuilder is indeed a new and strange world. This is due not alone to terminology and technique, but also to the unexpected manner in which the ship structural designer embraces the two precepts so heartily eschewed by Sir Francis Bacon, who said, "I had no hankering after novelty, and no blind admiration for antiquity." This policy is perhaps best illustrated by the all-out use of welding in present-day shipbuilding on the one hand, and the willingness to disregard or avoid the proved and accepted tools of the modern structural designer on the other. Because it is generally conceded that the strength of a ship, that is, of the "hull girder," as a whole is not susceptible of rigid mathematical analysis with present knowledge of the strength and resistance of materials, the ship designer is loathe to believe that the lesser elements of the ship's structure (decks, bulkheads, foundations, etc.) present relatively simple problems, for which ready and eminently satisfactory solutions can be found.

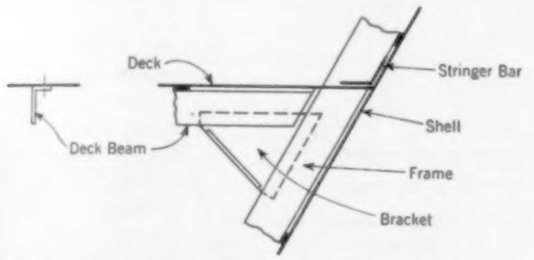


Fig. 1. Use of Angles in Shipbuilding

The basic structural elements that may be considered as making up that complex mechanism—the hybrid girder-building-pendulum—that we know as the ship hull, are the plate and the shape. The former may range from the finer sheet-metal gages up to several inches in thickness; the latter embraces practically every product of the rolling mill plus an assortment of formed and built-up sections, of varying degrees of merit, developed in design offices and shipyards.

Ever since the advent of Bessemer steel and the three-high rolling mill, the "angle-bar," or angle, has been one of the most widely used of all structural shapes. Its simple form, ease of manufacture, and ready adaptability have given it widespread use wherever structural steel is utilized. However, except in very light structures where the angle alone performs as a structural member, this shape is used primarily as a connecting member, and it is in this capacity that it most properly fulfills its intended purpose. The plate girder, the built-up column section, beam and girder end connections, the stringer-bar and boundary-bar in riveted ships—all are well-known examples of this application of the ubiquitous angle. In riveted ship construction the angle has been extensively used, *solitarius*, for frames, deck beams, and stiffeners, mainly because it is readily obtainable and fairly easily shaped and connected to other members. This use is illustrated in Fig. 1.

It is apparent, from a study of this detail, that the "faying" flange or leg serves merely to connect the working portion of the angle to the plate (shell, deck, or

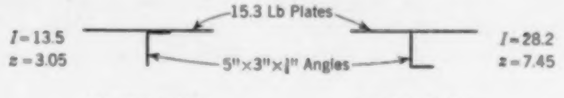


Fig. 2. Comparison of Riveted and Welded Angles

bulkhead), and contributes little to the strength in bending of the combined section (angle plus plate). Moreover, in the case of a "tight" bulkhead or deck loaded on the stiffener side, or in column action, the beam or stiffener has practically no element that can act as a compression flange to prevent lateral distortion. In an effort to overcome some of the defects of this singularly inefficient section, recourse was had to the bulb angle, reverse angle, face plate, and other stratagems; but none of these can be considered more than a cumbersome and costly attempt to correct a serious fault inherent in the angle itself.

Then came the welded ship, and someone, with what must be considered a stroke of genius, turned the angle upside down and welded the toe to the plate, thus creating the now familiar inverted angle. This simple expedient produced a more nearly balanced section, provided a flange to resist lateral deflection, and gave substantially greater strength without increase in weight. The riveted and welded angles are compared in Fig. 2. In this fairly typical instance it is seen that both the moment of inertia and the section modulus are more than doubled in the welded specimen.

The now widely used inverted angle, while having distinct advantages over the riveted member, still falls far short of the ideal beam or stiffener, if we apply the criterion of what should be modern design—greatest strength for lightest reasonable weight. Even the most casual consideration of the cargo ship and its function should make these precepts obvious.

The two major faults in the inverted angle are the following: (1) it suffers from what Professor Hovgaard in his book *Structural Design of Warships*, calls "the defect of unsymmetrical form," and (2) the relative thicknesses of web and flange are not properly proportioned for the most efficient use of the material in beam or column action.

*Federal Shipbuilding and Dry Dock Co.*

50-Ton Bow Section 60 Ft High, Prefabricated from 264 Pieces, with Mile of Welding

*Federal Shipbuilding and Dry Dock Co.*

TENNIS-COURT-SIZED UNIT OF TRANSPORT HAS BEEN INVERTED FROM UPSIDE-DOWN ASSEMBLY POSITION

The first of these reasons means, briefly, that beams which are unsymmetrical about an axis in the plane of loading, such as angles, Z's, and channels, have a tendency under load toward sideways deflection and twisting, with great consequent reduction in strength. The reason for this is that the resultant shearing forces acting on the beam do not pass through the "center of twist," and torsion results. The reduction in strength of such sections was found by Haigh (*Principles of Naval Architecture*, Rossell and Chapman, Vol. 1) to be as much as 33% to 55% below that of a symmetrical section having the same section modulus. Allowing for incompleteness of test data and other factors, it seems reasonable to assume a conservative 20% difference in strength in favor of the laterally balanced section. This value will be used later in effecting a comparison between the anachronistic angle and the T-Section.

The second of these reasons is perhaps best explained by the following argument. For the spans ordinarily encountered in shipbuilding, the design of a beam is practically always governed by moment; only in the case of very short beams or girders carrying heavy concentrations would shear, either vertical or horizontal, be of any consequence. From a study of the distribution of stresses in a beam subjected to moment, it is apparent that for rational and economical design the greater part of the material should be placed in the flanges. Due consideration must of course be given to web thickness, but only for the relatively unimportant factors of light shear stress, buckling, and corrosion. Never, for the spans found in a ship, should the web thickness approach that of the flange.

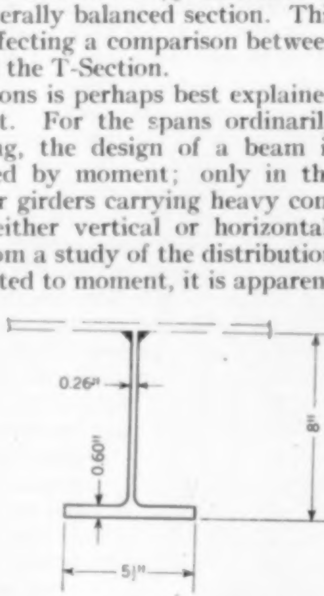


FIG. 3. SECTION OF HYPOTHETICAL T-SHAPE

In Fig. 3 is illustrated a hypothetical T-section, proportioned to approximate the strength in bending (unreduced because of asymmetry) of an 8 by 4-in. angle, a shape now in wide use for merchant vessel construction. A clinical analysis of the two shapes in combined form

TABLE I. ANALYSIS OF T-SECTION AND ANGLE SECTION IN COMBINED FORM

| Shape | Area | Weight per Ft | Combined $I$ | Combined $z$ | Combined $r$ | Combined $L/b$ |
|---|---|---|---|---|---|---|
| 8 × 4 × 5/8 angle | 7.11 | 24.2 | 151.0 | 26.7 | 4.6 | 66 |
| 8 × 5½ T-section | 5.22 | 17.7 | 157.5 | 28.2 | 5.5 | 48 |
| % in favor of T-section | 26.8% | 26.8% | 4.3% | 5.6% | 19.5% | 27% |

(shape plus plate) appears in Table I. An examination of the values in this table shows that the T-section has a marked structural superiority on all counts: stiffness, $I$; strength, $z$; stability in column action, $r$; and lateral stability of the compression flange in bending, $L/b$, while at the same time the most important economic factor, weight, is 27% lower.

In Table II another comparison is made between a conventional 7 by 4 by ½-in. angle and a theoretical T-section. Here again the superiority of the properly proportioned member is obvious.

TABLE II. COMPARISON OF ANGLE AND THEORETICAL T-SECTION

| Shape | Area | Weight per Ft | $I$ | $z$ | $r$ | $L/b$ |
|---|---|---|---|---|---|---|
| 7 × 4 angle | 5.25 | 17.9 | 89.9 | 18.23 | 2.86 | 5 |
| 7 × 5 T-section | 3.97 | 13.5 | 90.8 | 18.40 | 3.06 | 4 |
| % in favor of T-section | 24.4% | 24.4% | 1.0% | 1.0% | 7.0% | 20% |

It is estimated that the use of a shape similar to that shown in Fig. 3 in a vessel of the Maritime Commission's C-3 type would effect a saving of 120 tons or more, while producing a considerably stronger ship. While this tonnage may not be a very high percentage of the total steel used in the construction of the vessel, it still represents 50 crated automobiles or a half dozen switching locomotives left on the pier when the loaded vessel has already "taken her marks." And this must go on for the entire economic life of the ship, perhaps twenty to thirty years.

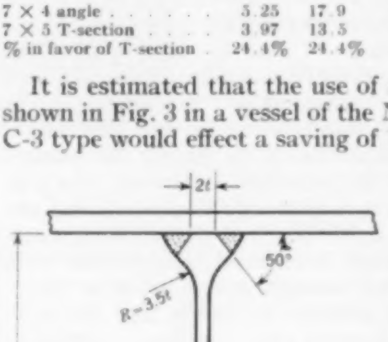


FIG. 4. SECTION OF PROPOSED SHIP T-SHAPE

In Fig. 4 is presented a rolled shape for use in ship-building or other welded plate construction. It has all the virtues of the T-section already discussed, plus a stem or web expressly adapted to the welding technique. It cannot be approximated by splitting present wide-flange or standard beams because the web and flange thicknesses of the beams as rolled are proportioned for greatest efficiency of the full-depth beam, and not for a section of one-half the depth. Some of the advantages of the proposed shape are:

1. It has symmetry and a wide flange, both contributing to lateral stability and torsional resistance.
2. It has properly proportioned web and flange thickness, giving high flexural efficiency.
3. It has a thickened stem to equalize heating of the connected parts, and is shaped to provide automatically a properly sized fillet weld.
4. It presents no difficulties in rolling.
5. It is specifically engineered for its purpose.

TABLE III. COMPARISON BETWEEN PROPOSED SHAPE OF FIG. 4 AND SPECIALLY ROLLED ANGLE

| Shape | Area | Weight per Ft | $I$ | $z$ | $r$ | $L/b$ |
|---|---|---|---|---|---|---|
| 9 × 4 angle | 7.73 | 26.3 | 157.6 | 25.2 | 3.6 | 12 |
| 9 × 6 T-section | 7.55 | 25.7 | 245.1 | 42.7 | 4.1 | 7.6 |
| % in favor of T-section | 2.3% | 2.3% | 55.5% | 69.5% | 14.0% | 37% |

In Table III a comparison is made between a shape proportioned as indicated in Fig. 4, with a depth, $H$, of 9 in., and one of the specially rolled 9 by 4-in. angles now in use. The values are adjusted in accordance with the principles that have been outlined. The conclusions are obvious.

# Dust Laying on Roads at an Advance Base

*By* W. N. Taggart, Jun. Am. Soc. C.E.

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Recent experience has brought out the advantages of using ships' bunker oil ("C" grade) on coral roads to obtain a smooth, hard, dust-free surface suitable for military transport. The plan, as adapted to work on a Pacific island, was originated by the Transportation Department of the 84th U.S. Naval Construction Battalion and was supervised by the writer, at that time transportation officer. It was first used at the Naval Section Base with very satisfactory results. The second experimental section was on a main road near hospitals, where the elimination of dust was of prime importance. As a result of these two experiments and through the U.S. Army Engineers' requests, the oiling program was considerably extended to include large sections of the road system on the island.

### Some Preparatory Procedures

Road material varied from a mixture of approximately 10% clay and 90% coral to 90% clay and less than 10% coral, with the remainder of loam or other fines. After the middle of October steady rainfall practically ceased, and there was an average of only two or three heavy showers per week. It was just about then that the roads on the island were completed. They became so dusty, at times, as to reduce the sight distance to less than 50 ft on a bright day. After a shower these same roads would become muddy and dangerous, owing to a very slippery surface. The main objective of our work was to eliminate or cut down the dust and also provide an all-weather surface which would repel water at least to a limited degree.

Before oiling a section of road, the condition of the surface was carefully considered. If it was smooth and packed hard with a minimum of fines, no preliminary work was attempted. If it was smooth with a large amount of fines, the section was thoroughly wetted down with salt water by sprinkler trucks. This would tend to compact the fines through traffic action.

For a rough surface with a large percentage of fines and sandy material, a motor-patrol grader would be used to crown the road and give a good grade. Working in conjunction with the grader, a sprinkler truck would keep the working area as damp as possible. This grading was done as long as a week before oil was available; in the meantime, the section would be kept moist with salt water. The further sprinkling would tend to keep the dust down, and pack the surface and make it ready to receive the oil.

In preparing to combat the dust problem, the Transportation Department took two trucks and mounted a standard pontoon cube, of 1,100-gal capacity, on the bed of each; one was a 4-by-4 (4 wheels, 4-wheel drive), $2^1/_2$-ton dump truck, and the other a 6-by-6, $2^1/_2$-ton dump truck. Both were fitted with a sprinkler bar. The 4-by-4 truck was gravity fed, whereas the 6-by-6 was pressure fed—that is, an attached jeep motor and pump pumped from the pontoon to the spreader bars, or by use of valves, through a hose that might be used for fighting fire. Both trucks handled salt water or oil.

Dusty Road Section Before the First Oil Application


Australian Engineers' "Little Ford" Pressure Distributor Beginning Operations on the Section Shown Above

The Same Road Section Approximately Four Hours After Completion of Treatment

Then, in addition, a standard asphalt pressure spreader was borrowed from the Australian Airport Engineers. This truck had a capacity of 1,000 gal. To supplement it, a standard 1,250-gal tow trailer, equipped to lay oil under pressure, was borrowed from the U.S. Army Engineers for a short period when most of the oiling projects were in the initial stage.

For exclusive use in laying the salt water, two 6-by-6, 5-ton dump trucks having pontoon cubes and mounted with spreader bars were borrowed from the U.S. Army Engineers, as was a 1,500-gal tow trailer. All of these units constantly patroled the sections awaiting oiling and also periodically covered sections previously oiled.

The availability of oil for the roads depended upon the ships that happened to be at the various docks—this was the only source. A suitable connection was fabricated in the Seabee welding shop to reduce the oil-pipe size at the ship to fit a fire-hose connection. The oil was carried over the side through the hose to the waiting truck on the dock.

When a road section was to be oiled, proper warning signs were placed at each end to caution drivers. The

MECHANICAL EQUIPMENT FOR DUST-LAYING OPERATIONS

Vehicles, from Left, (1) Seabee Pressure Distributor on 6-by-6 Truck Showing Jeep Motor and Pump, with Spreader Bars Attached, Equipped with Standard No. 3 Spray Tips. (2) Seabee Gravity-Feed Distributor on 4-by-4 Truck. Spreader Bar Is Drilled with 1/4-In. Holes on 4-In. Centers, One Row Vertical and a Second at 45°, to the Rear. (3) U.S. Army Engineers' 1,500-Gal Tow Trailer for Laying Water. Gravity Feed to Pressure Bar. (4) U.S. Army Engineers' 1,200-Gal Tow Trailer, with Pressure Distributor

oil-laying trucks spread the oil on the shoulder and part of the adjoining lane for the length of the section, returning on the opposite side and following the same procedure. This left the center section open to traffic. Generally the section selected was just long enough to consume one load per round trip.

Frequently the second truck could not be loaded in time to continue immediately with the oiling of the center strip. This lag had the advantage of enabling traffic to use the dry section and also of allowing time for some of the oil to be absorbed. When the center section was oiled, traffic played an important part in settling the surface. Wheel action tended to spread the oil and roll it in. After four to five hours most of the oil appeared to have been absorbed, leaving a smooth, black, dust-free roadway.

Work was generally based on a 7-hour work day, 6 days a week, but during oiling operations a full 8 to 9 hours were utilized. The average rate of consumption was 285 barrels a day. The oil was spread at approximately 0.32 to 0.36 gal per sq yd for the original treatments and 0.08 to 0.09 gal per sq yd for succeeding applications.

The pressure trucks, including the $2^1/_2$-ton 6 by 6, operated at a speed of 17 mph and covered a lane 10 ft wide for 1.7 to 2.0 miles, giving an average coverage of about 0.08 to 0.09 gal per sq yd. The gravity-feed truck operating at 21 mph covered approximately 8 ft for 2.8 miles, giving an average of about 0.07 to 0.08 gal per sq yd. Generally the gravity-feed truck on first-application work operated at 20 mph, but on touch-up coats it operated at about 25 mph, giving a coverage of approximately 0.06 to 0.07 gal per sq yd. To achieve the coverage of 0.32 to 0.36 gal per sq yd for original application, required four trips over the area, usually on four successive days. It happened many times that showers occurred during the night. However, if the surface was packed from the preceding day's oiling, no appreciative damage to the road surface or loss of oil occurred, although a small percentage was washed away.

With all trucks hauling water, except the Australian, about 52,000 gal of salt water were pumped per hour. To handle this, a salt-water point was established adjacent to a Navy jetty at the shore line. A fire pumper unit placed at the end of the jetty supplied the water through fire hose and a $2^1/_2$-in. pipe line. Two trucks were filled simultaneously. A relief valve was installed to allow continuous operation of the pump at 70-lb pressure and to prevent the bursting of the hose when the valves were closed between truck loadings. The average time required to fill a pontoon cube was 7 min.

As a result of oiling, maintenance was found to be very much reduced. One section did not need motor-patrol maintenance for six weeks, during which time it was subject to a considerable number of heavy showers. Another section, reputed to carry the heaviest traffic—800 units per hour—had not been retouched for about eight weeks. Those sections, however, did receive a second application of oil approximately three and four weeks after the original treatment. Both had a firm subfoundation of coral, while most other oiled sections were constructed with a thin layer of coral over the original earth, bladed and crowned. These latter sections required about two-thirds more maintenance than did the coral-base sections.

From observation it is believed that these oiled surfaces will not require motor-patrol attention for a period of five or six weeks for the coral-base roads, and of two to four weeks for the common soil base sections. Such grading would consist of a cut only deep enough to smooth out the slight irregularities and fill the depressions. When oil is available, a light coat should be given all treated surfaces every two or three weeks regardless of the surface conditions; it is preferable to lay this coat immediately after motor-patrol touch-up.

It was found that when no oil was available, a wetting of salt water would achieve about the same results. The action of the salt water and oil appears to further consolidate the surface and also to spread the oil that has been absorbed. The intense action of the sun draws the oil to the surface, and wheel action tends to keep it distributed. Also, a small percentage is carried away while some evaporates, thus requiring that the surface be oiled periodically or wet with salt water.

### RESULTS ARE BENEFICIAL

It was found desirable to oil during early morning or midday so that the heat of the sun could be utilized in the afternoon to spread the oil film. During the night traffic further rolled and spread the oil so that by the next morning none was visible on the surface. The road was black and the surface hard, but still a bit plastic, although not to such a degree that mud-grip tires would dislodge it. The third day after completion of the primary coat, the surface was both hard and firm and there was no dust. The pavement was as smooth as could be expected, considering the type of road material, subbase, traffic volume and loadings. The surface would even sustain caterpillar tread when the unit traveled at slow speed. The pavement that was dislodged packed back into place and in a short time again presented a smooth surface. After continued wetting and oiling, the pavement would not be cut by track treads.

The outstanding benefits obtained through the use of grade "C" bunker oil in laying the dust were:

1. Better welfare of the personnel who must travel the roads constantly.
2. Elimination of dust which might cause infections.
3. Easing discomfort from dust on the part of patients confined to hospitals.
4. Doing away with dangers due to short sight distances on the road.
5. Reducing maintenance of vehicles operating under excessively dusty conditions.
6. Clearing the air and thus reducing diffusion of lights or sky glow, which might be an aid to the enemy.

# Reconstructing Western European Railroads

## *Army's Remarkable Exploits in Replacing Bridges, Track, and Water Supply*

*By* Emerson C. Itschner, Assoc. M. Am. Soc. C.E.

Colonel, Corps of Engineers, U.S. Army; Engineer, Advance Section

*Supplies are the life blood of an army, and transportation its arteries. Hence one of the first and greatest problems in assuring the European triumph was to reinstate rail service. The accomplishments of American engineers in France, Belgium, and Germany have been widely acclaimed. Colonel Itschner's article gives first-hand proof of why this is more than justified. "Superhuman" describes the efforts and "unbelievable," the results.*

"General Patton has broken through and is striking rapidly for Paris. He says his men can get along without food, but his tanks and trucks won't run without gas. Therefore the railroad must be constructed into Le Mans by Tuesday midnight. Today is Saturday. Use one man per foot to make the repairs if necessary."

Such were the amazing instructions given to the Engineer, Advance Section, after sunset on August 12, 1944. In 75 hours a railroad 135 miles long had to be reconstructed. This entailed the replacement or repair of seven bridges; the removal of wrecked rolling stock and track from three badly bombed railroad yards; filling craters, preparing subgrade, and relaying at least one track through those yards; restoring track in many places on the main line where it was bombed out; and providing for watering and coaling facilities and passing tracks.

Approximately 2,000 troops had just started to work on a small part of the line at the time. While an additional 8,500 troops were available, they were scattered widely, and communication, except by motor messenger, did not exist. There was no hope of getting sufficient materials to the site from depots in time to be of value. This compelled the use of locally available materials and the "cannibalization" of undamaged portions of track not immediately needed.

Some of the 9,000 troops employed did not arrive on the project until 24 hours prior to the deadline, while equipment moved even more slowly on the terribly congested roads. Nevertheless, it became apparent that the line would be open in time with the probable exception of an 80-ft single-track bridge at St. Hilaire du Harcourt which had been dropped at one end when the abutment was destroyed. The other end had slipped sideways off its seats, but was still resting on the intact abutments.

As Maj. Gen. Cecil R. Moore, Chief Engineer, European Theater, and the writer flew over the line six hours before the deadline, they saw spelled out on the ground in white cement at the St. Hilaire bridge site the words: "Will finish at 2000." The 347th Engineer General Service Regiment had jacked up the old bridge and inserted a crib as a new abutment. Many of the officers and enlisted men had not slept during the entire three days! The railroad was opened on time, and 30 trains loaded with vital supplies for General Patton started rolling as the last spike was driven.

This was the first of a long series of continual crises that ended only when a vast railroad net had been opened through France, Belgium, Luxembourg, and Germany to the Elbe River, and into Czechoslovakia and Austria. During the Continental campaigns Advance Section Engineers restored to service more than 11,600 miles of track, and constructed 420 bridges with an average length of 137 ft. The extent of this work is shown graphically in Fig. 1.

In general, there were two distinct purposes to be considered in the selection of rail routes. As the armies advanced, there was an immediate and urgent need for at least one group of railheads located close to the front, but out of effective enemy artillery range, and served by a minimum of one double-track railroad per army. To accomplish this first objective, poorer railroads from the standpoint of grades, condition of track, weight of rail, and curvature, were acceptable; and short stretches of single track were not considered objectionable.

On the other hand, the more permanent arterial lines of communication had to be reconstructed along routes selected by the Military Railways Service. These railroads necessarily followed routes permitting economical operation, and frequently they had higher and longer bridges and more tunnels. Naturally they had undergone greater demolition because both our Air Force and the enemy engineers gave priority to the principal lines. Consequently, it was often necessary to reconstruct a poor detour route for immediate use, and then start the bigger task of restoring the main line.

Track damage on the whole was not as great as had been anticipated. Most of it was caused by our bombing

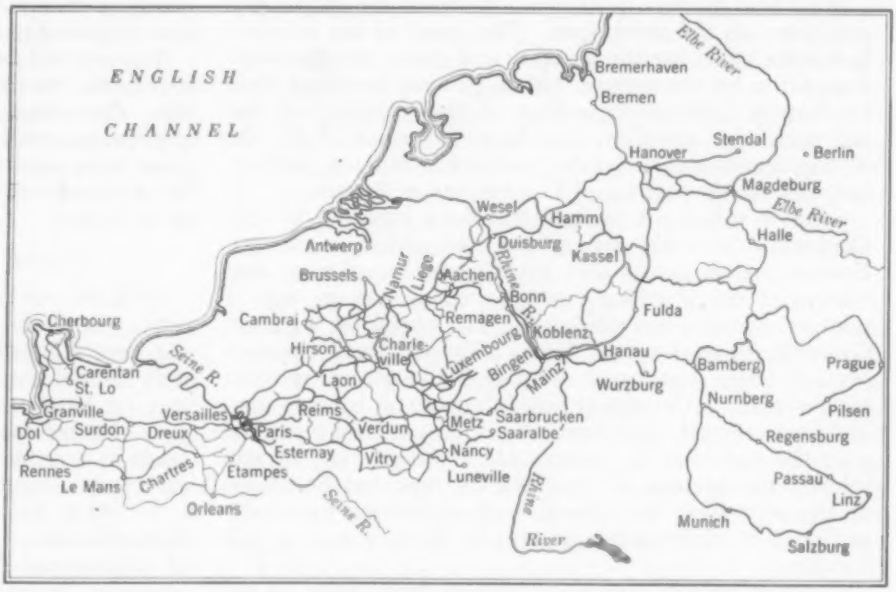



Fig. 1. European Railroads Rehabilitated by Advance Section

Mainz Crossing Over Rhine Is 2,221 Ft Long
Now Named the Franklin D. Roosevelt Memorial Rail Bridge

of railroad yards and factory areas. Occasional bombs fell on the right-of-way between cities, and usually there were a number of large craters near bridges that had been bomb targets. Where fighting had been intense, there were a large number of track breaks caused by artillery and small-arms fire, especially mortar fire. Track was damaged in many places where enemy trains had burned as a result of strafing by our Air Force. Here and there the Germans had removed one track in order to repair the other.

Deliberate track demolition by the enemy was rare except in the area between Metz and the Saar, where the fighting was prolonged. Usually the blowing of a few switches constituted the entire damage, but in the area east of Metz the track destruction was severe. In one stretch 28 miles long there were 6,000 rail breaks and 2,500 broken ties. The famed German track ripper had been used for only about 12 miles—in short stretches, each seldom over a mile in length. These huge hooks required three locomotives for traction. When they were used, however, they did a complete job. Two unused rippers were found in France. Many of the railroad yards were a tangled mass of demolished rolling stock, track, and appurtenances, with water-filled craters everywhere. Even by careful selection it usually was difficult to find a single through track that could easily be restored to operation.

Most bridges were destroyed, especially the larger ones and those on the main lines. The speed of our advance had some effect on the amount and character of bridge demolition by the enemy, but in general he found time to destroy bridges regardless of the rapidity of our progress. In addition, our bombing resulted in the destruction of a considerable number of bridges, particularly across the Seine and Loire rivers in France.

Some bombed-out bridges had been repaired by the Germans. Since the majority of the bridges in western Europe are masonry and usually only one span was destroyed by bombing, making these repairs was a relatively simple and quick job. The bridge on the main Granville-Paris line at Dreux, France, was bombed several times but never damaged enough to prevent rapid repair. (A bridge at best is hard to hit by bombing, and for every hit there are always many misses scattered over the surrounding countryside.) Finally the French inhabitants became so harassed by repeated bombings of the structure that the French resistance forces demolished it thoroughly one night, leaving not a pier standing.

German bridge demolition varied from poor to excellent. It was surprising how many charges were found that had not detonated. Usually the Germans attempte to blow only one or two arches of a multiple-arch m sonry bridge, and the truss near one end only of a ste bridge. Had piers been demolished at their base mo frequently, the repair task would have been more difficul Similarly, it was fortunate abutments were rarely blow

Very few tunnels were demolished, probably becau most of them were through relatively dry rock. Unle a tunnel is through a material that flows, such as san or through a structure that produces a large amount water, its repair is not difficult.

Track repair consisted in the removal of demolish rail and ties, pumping water out of craters, and filli with material borrowed nearby, using bulldozers a occasionally dump trucks to make the fill. While eve effort was made to obtain compaction by the use of bu dozers, the length of fill was so short in many cases th the material was pushed into place from the side up steep incline, resulting in relatively little compactio Consequently maintenance was very heavy the first wee after a line was opened. Derailments, even at low spee were frequent for a period after new track was opened u particularly with stiff new American freight cars, whi were not designed to ride the rough track that must b expected initially in military operations.

Continental rail came in many sizes and shape principal main-line track being between 46.3 and 50 (93 to 100 lb), both flat-base and bull-head, Frenc Belgian, and German types. American 75-lb rail w used as replacement only when rail could not be foun locally. Mills were opened in Belgium, where adequa rail was rolled to fill all subsequent needs. Splice ba were found in stock, salvaged or manufactured; co promise bars to join the many types of rails were ma in field shops by welding. An effort was made to redu the number of types of rail in a stretch; often this w accomplished by "cannibalizing" similar rail from li not currently needed.

While many steel and wood ties, and a few of concre are used on the Continent, wood ties were used as replac ment because they were usually easy to obtain local and our troops found it easier to lay them. Lag scre and studs with rail clips are used extensively on Europe railroads, but our engineers used spikes because they we quicker. Ballast was required only where the origi had been disturbed. Obtaining rock was not a serio problem except at Cherbourg, where huge quantiti were required in constructing large yards.

The original damaged watering facilities were repair if possible, much welding being required to accompli this. Otherwise, a standard 12,800-gal tank with a 30 gpm pump was installed. At times fire hose and equi ment were used as an expedient to fill temporary tank It was considered essential to provide 500 to 600 gpm the tender.

#### VARIED TYPES OF BRIDGING AVAILABLE

Bridges comprised the major portion of railro work. Several types of British standard railroad brid ing were stocked in rear depots. It was intended th they should satisfy all requirements that could not b met by local materials. These types comprised:

1. Rolled Steel Joist Spans (RSJ)—an I-beam brid made in lengths of 17 to 35 ft, with 2 or 3 beams benea each rail. Diaphragms and lateral bracing are include
2. 40-ft Sectional Girder—a 40-ft, 4-girder brid that splits into 6 parts, each part consisting of two gird of approximately one-third the bridge length. Di phragms, lateral cross frames, and bracing angles a provided.

BOMBED RAILROAD YARDS AT ALENCON, FRANCE

This Devastation Typical of Damage to Small Yards in Western Europe; Large Yards Frequently Much More Extensively Injured

3. Unit Construction Railway Bridge (UCRB)—a through or deck-type truss railroad bridge in multiples of 5 ft in length up to 85 ft. The through bridge uses 2 or 4 girders; the deck bridge 2 or 3 girders.

4. Light Steel Trestling (LST)—a trestling or pier material capable of rapid erection, forming columns spaced at 5 by 5 ft. By proper combination of various standard length columns, the height of pier can be made to meet any requirements.

5. Standard Steel Trestling (SST)—similar to the LST, but heavier, being used for exceptionally high piers or to support unusually heavy structures.

However, the vast majority of bridges were built with meter-depth I-beams, found across France here and there in small quantities where the Germans had shipped them for bridge repairs. Such beams were later rolled in large numbers at a Luxembourg mill under Advance Section Engineers. These huge beams, over 39 in. in depth and up to 95 ft long, were used almost exclusively across and east of the Meuse River. Four beams per track spanned up to 70 ft, and six beams up to 95 ft, affording a Cooper's E-35 loading at reduced speeds.

The production of these beams so close to the front saved the shipment of large tonnages of prefabricated bridging from Cherbourg. So critical was the transportation situation that shipping the bridging would have meant an equal reduction in the amount of food, gasoline, or ammunition shipped to the front. Therefore this beam production was of the greatest importance, and without it the rail network possible of reconstruction would have been only a small fraction of the one actually restored. Some trestling was designed and fabricated in Luxembourg and Belgium, but LST was always in demand because it could be erected so quickly.

### THE GENERAL PROBLEM OF BRIDGE REPLACEMENT

Many types of bridge construction were employed. Existing piers were used where possible. Sometimes these were leveled off and capped with concrete at a point where they appeared solid, and built up to the required height with steel or timber piers, cribbing, or beams if the distance was short. Piles were often driven for piers—frequently through holes cut in the debris of the demolished steel bridge. Masonry bridges usually formed large piles of rubble when they dropped. This formed an excellent base for piers, especially when concrete foundation blocks were poured; however, care had to be exercised to prevent the erosion of the pier base during floods. The use of timber cribbing in lieu of piers was avoided in order to conserve lumber, which was always scarce; a few bridge reconstructions, however, did employ this material.

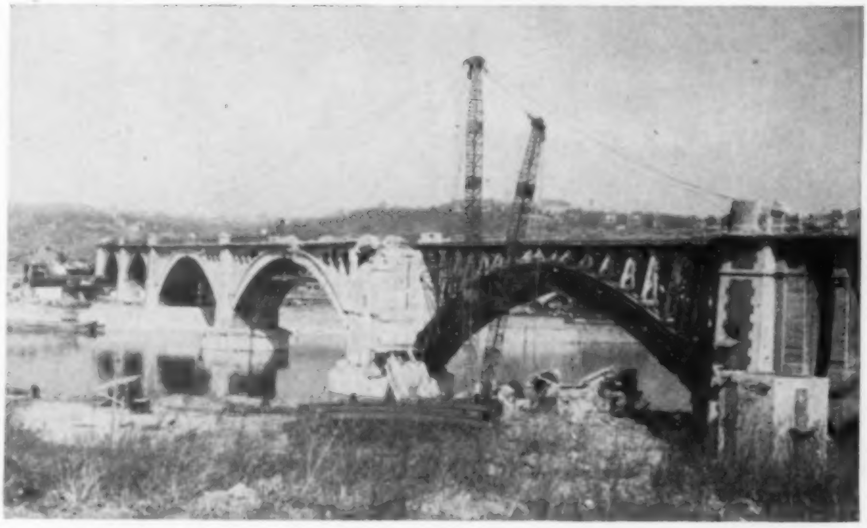

RAILROAD BRIDGE 65 FT HIGH REPAIRED AT KORNELIMUNSTER, GERMANY

Meter Beam Spans Supported by Steel Piers—All Materials Produced on the Continent by Advance Section

Care was always taken to place the seat for beams or prefabricated bridging crossing a demolished masonry arch squarely over the pier. Also, masonry-arch bridges were supported by struts across the demolished span when it was considered possible that the horizontal component of the adjacent arch thrust might cause the pier to overturn. In one case several arches on very high piers fell progressively of their own dead load weeks after the original demolition of some adjacent spans, but before work could commence on the bridge.

Beams or trusses were erected by several methods, the use of cranes to lift them in place being the most popular, where feasible, even though considerable work was necessary to construct a ramp out into the river to support the cranes. Many beams were launched by welding two beams end to end and rolling them into place at track level. This worked well when there was an intermediate pier, so that both beams were used in the structure. UCRB's were launched by a standard launching nose and special cars that rode the regular track.

Most successful of the launching methods was the use of a "Long Tom" launcher, an improvised device mounted on a flat car, consisting of a trussed meter beam



LARGE MASONRY RAILROAD BRIDGE AT RENORY, SOUTHWEST OF LIÉGE, BELGIUM
Steel Arch Was Found to Replace Destroyed Span

or a UCRB, mounted so that it reached out over one end of the car 45 to 50 ft. The beam was lifted by tackle from the end of the boom, and the flat car was then rolled to a spot from which the beam could be dropped into place. One unit developed a super-launcher they called a "Mobey Dick," supposedly capable of lifting an entire span instead of just one beam. In practice it never worked, except as a threat to officers in charge of jobs not progressing as favorably as they should, for when they heard that Mobey Dick was being sent up to them, they redoubled their efforts to get the work done before the cumbersome device arrived.

Some of the more interesting projects will be described. They represent only a minor fraction of the work accomplished but they serve to illustrate well the various methods and expedients adopted.

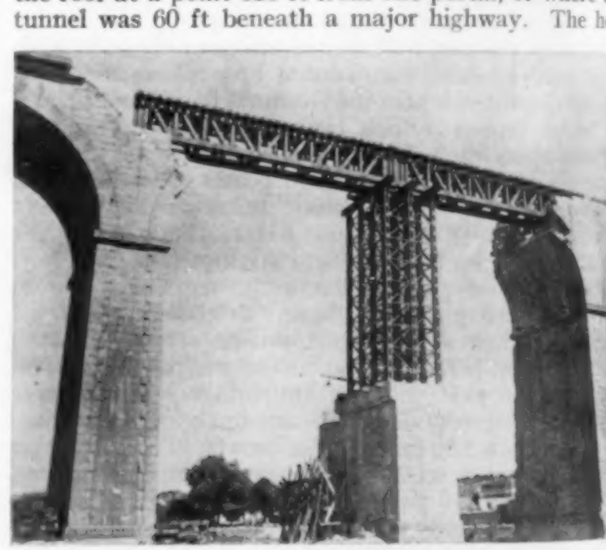
The third railroad bridge across the Rhine was constructed at Duisberg, Germany. Mobilization of equipment and materials began April 24, 1945. Construction started on May 2, and a test train passed over the bridge 6 days, 15 hours, and 20 minutes later. The total length is 2,815 ft, consisting of 38 spans, including one navigation span of 88 ft, 35 spans of 75.5 ft, and two shorter shore spans. While meter beams were used on 24 spans, UCRB's were used on 14 spans in the flood plain. Both timber and steel H-beam piles were driven to at least 20 ft of penetration from five skid-rig pile drivers mounted on Navy Lighterage (NL) ponton barges (composed of steel cells, each 5 by 5 by 7 ft). The barges were 4 cells wide and 12 long. Simultaneously three $1^1/_2$- or 2-yd crawler cranes with swinging leads and steam hammers drove piling for the land piers. These piles had been placed in holes drilled by truck-mounted earth augers as a means of expediting driving and accurately spotting piles.

Cranes were used to place steel, some being mounted on additional NL ponton barges. Light steel trestling (LST) piers were assembled on shore and placed as a unit on the capped pile piers. A large amount of grading was required on one end of the bridge. All bracing of I-beam stringers was welded. The splendid achievement of building a substantial pile bridge across the Rhine in less than a week could only have been accomplished by seasoned troops working at top speed with a perfectly conceived and executed plan.

The Hergenrath (Belgium) bridge was a high structure on the line between Liége, Belgium, and Aachen, Germany. It consisted of two completely independent parallel truss bridges, one for each track. The Germans had spent four years in building one of these bridges, and had had it in use only 28 days when they demolished it. The more favorable of the bridges for reconstruction had a 220-ft gap 110 ft high.

Steel piles were driven to support a steel tower 40 by 40 ft at the base. Local inhabitants stated that the Germans had found that piles drove out of sight in the soft soil of the bottom of the valley, but actually driving appeared normal. The pier was prefabricated in a Liége shop; this took much longer than had been anticipated owing to the intensive V-bomb attack on that city. It tapered to 10 ft wide at the top, retaining its 40-ft length. This long pier top enabled the gap to be spanned by two meter-beam spans plus a smaller beam across the tower; whereas two piers would have been required had the length of top of pier been less. This job, like many others, was constructed entirely of materials manufactured under the auspices of Advance Section Engineers on the Continent. It took two months to construct, the prefabrication of the tower consuming much of the time.

On the same line, near Aachen, there was a double-track tunnel 2,280 ft long that had a hole blown through the roof at a point 325 ft from one portal, or where the tunnel was 60 ft beneath a major highway. The hole



TWO-SPAN UNIT CONSTRUCTED BRIDGE AT LAVAL, FRANCE
Demolished Concrete Arches as Abutments for UCRB Trusses; at Center, LST Pier Replaces Removed Masonry, Which Had Been Badly Shattered

was 56 ft long, and the fine sand that seemed to be the entire cover spread out to a width of 100 ft along the tunnel floor. An effort was made to drive steel sheet piling horizontally through the spoil just inside the tunnel lining. It was then planned to remove the sand, progressively placing heavy H-beam, five-segment arches supported by two vertical posts every 2 ft of tunnel length to support the steel sheet piles.

When driving became very difficult after about 10 ft of penetration, it was decided to excavate the upper half of the sand as far back as possible without causing additional running, and to place the arch rings in position

then to drive the piling a few more feet, and repeat the process. This method was soon abandoned when it was discovered that the sheet piling bent so badly between rings due to pressure from outside that driving became impossible. The job was finished by using 12-ft sections of sheet piling as lagging and supporting it as before. This conventional method worked well, and the job was completed expeditiously.

The Renory viaduct, in Liége, was an unusual project. It provided the fourth track crossing the Meuse River within the city. It was built as a reserve crossing should one of the many V-bombs strike the existing bridges, as well as to provide the best operating line from Antwerp, Belgium, through Liége into Germany. One 220-ft span had been demolished. As in most other projects, there was much minor work as well, including repairs to an abutment and the removal of two 8-ft reinforced concrete block walls from a nearby tunnel used by the enemy for ammunition storage. Steel arch supports for the concrete form utilized in the original construction in 1929 were located, and four of these arches were used to support the new bridge. A typical trestle bridge was built on top of the steel arches. One V-bomb cracked a pier during construction, necessitating considerable additional concrete work. Others caused eight casualties.

The Vire River bridge near Isigny, France (not far from Carentan), consisted of two parallel independent spans, each blown at one end, the other end resting on the abutment. The first reconstruction at the site consisted of a timber trestle bridge supported on the original bridge, which reclined at about a 20-deg slope. While the original structure appeared to be resting on a firm bottom and in no danger of settling, sliding downstream, or slipping off the abutment, piles were driven and the lower end of the bridge was fastened to them. Later the parallel span on the other track was raised by driving a temporary pile gantry and hoisting, using a tank retriever as the source of power. A permanent pile pier was then driven to support the shortened span. This job was done under enemy artillery fire. In one day over 70 shells, obviously aimed at the bridge, which was under direct enemy observation, landed nearby, and at least four hit parts of the bridge. Large pieces of equipment attracted especial attention from the enemy, and had to be withdrawn when artillery fire became intense.

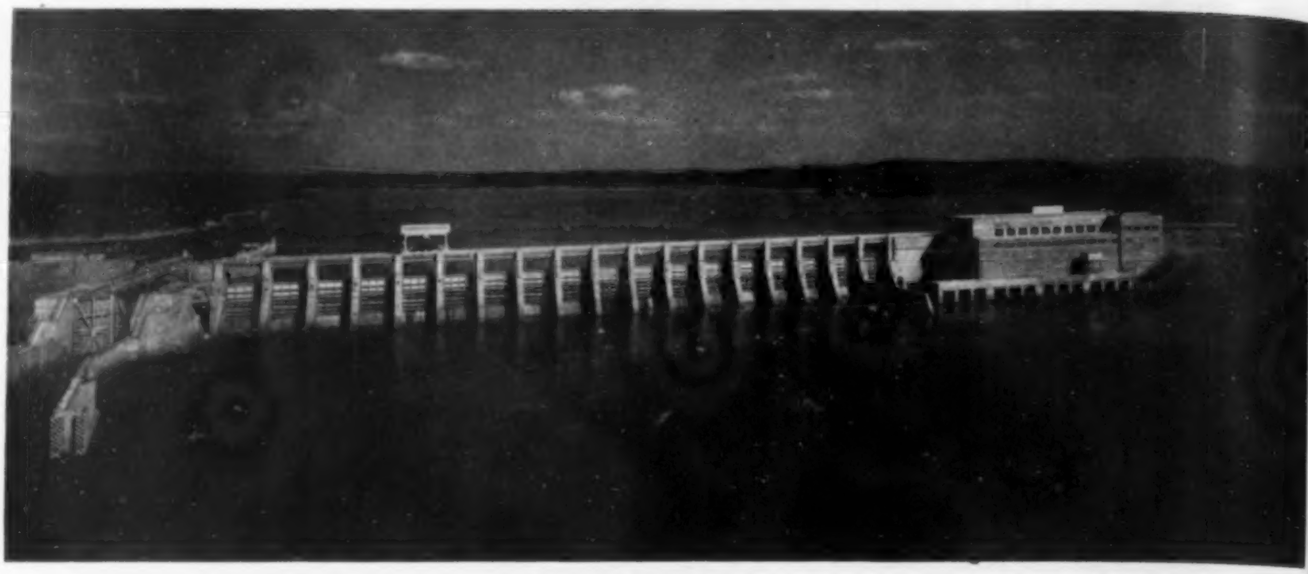
Almost every project was different, and a number of expedient methods were developed. Occasionally bridge spans were filled in by bulldozing. One arch ring was repaired by a self-supporting form that relied upon the railroad rail reinforcing for its entire support. Both horizontal struts and knee bracing to a foundation block served to take horizontal arch thrust. Often partially demolished masonry arch spans were left in place, as they were capable of taking the thrust of the adjacent spans, and an I-beam span was constructed over the arch but not touching it except for the fact that it was seated on the piers.

CENTER SPAN OF HERGENRATH BRIDGE, BELGIUM, IS ARMY'S HIGHEST STRUCTURE IN EUROPEAN THEATER (116 FT); IT REPLACES SPAN DEMOLISHED BY RETREATING GERMANS

WESEL BRIDGE, BUILT IN 10 DAYS, WAS FIRST ACROSS RHINE
Meter Beam Spans on LST Piers Which Were Assembled on Span, Barged to Position and Placed on Capped Timber Piers. Now Named the Maj. Robert A. Gouldin Bridge

In one case, during the second highest flood of record on the Moselle River, burned-out enemy tanks were used as revetment to protect an abutment against scour. Frequently repairs were necessary on otherwise sound bridges to strengthen members damaged by shells or bombs. This was usually done by welding, although entire members salvaged from identical bridges were substituted in a few instances. Much of the permanent repair of Continental bridges is done in this piecemeal fashion, by salvaging all sound members and replacing damaged parts with newly fabricated identical members.

For these remarkable operations Maj. Gen. Cecil R. Moore, was Chief Engineer, European Theater. Colonels John R. Hardin and Paul D. Berrigan, M. Am. Soc. C.E., were his Deputy Chief Engineer and Chief of the Construction Division, respectively. Maj. Gen. Ewart G. Plank, M. Am. Soc. C.E., commanded the Advance Section, while Col. Alvin G. Viney was his Chief of Staff. Col. A. H. Davidson was Deputy Engineer to the writer, and Col. Wilson B. Higgins was Chief of the Railroad Construction Division. Field construction units, composed of as many as 13 Engineer General Service Regiments at one time, were employed on railroad construction, as were an Engineer Construction Battalion, Dump Truck Companies, Port Construction and Repair Groups, Combat Battalions, and Welding Detachments. These units were grouped as follows: Group A, Col. Helmer Swenholt, commanding; Group B, Col. Harry Hulen, commanding; Group C, Col. Edwin H. Coe, commanding; 1056th PC&R Group, Col. James Cress, commanding. Much help was obtained from the French and Belgian railroad personnel, from the Railway Operating Battalions of the Transportation Corps, and from two Railroad Construction Companies of the French Army. In addition, German prisoners and civilians were used extensively.



CHICAMAUGA DAM ON THE TENNESSEE RIVER IS TYPICAL OF TVA MAIN-RIVER PROJECTS

# Federal Multiple-Purpose Projects

## *Part II. Financing Surveys and Construction*

*By* ALFRED R. GOLZÉ, ASSOC. M. AM. SOC. C.E.

ASSISTANT DIRECTOR, BRANCH OF OPERATION AND MAINTENANCE, BUREAU OF RECLAMATION, WASHINGTON, D.C.

*PLANNING, design, construction—these are not the only responsibilities of the engineer in bringing a multi-purpose hydroelectric project into being. The work must be financed and in this phase of the work also, as Mr. Golzé points out, engineers figure conspicuously. The procedure of authorizing and appropriating funds differs somewhat, depending upon the agency responsible for the project under consideration. In all cases, the Bureau of the Budget coordinates proposed undertakings and determines their place in the President's program for the development of national resources.*

STUDIES and examinations made by various agencies and leading toward the eventual authorization of federal projects are financed in different ways. The Corps of Engineers, for its civil work, receives each year three major lump-sum appropriations—for rivers and harbors, for flood control, and for Mississippi River flood control. In justifying its estimates for these appropriations, the Corps shows what portion it proposes to spend on preliminary investigations and furnishes a list of projects, all of which have been authorized by appropriate Congressional legislation. If Congress fails to appropriate the full amount estimated, it is necessary for the agency to revise its list after the appropriation is available.

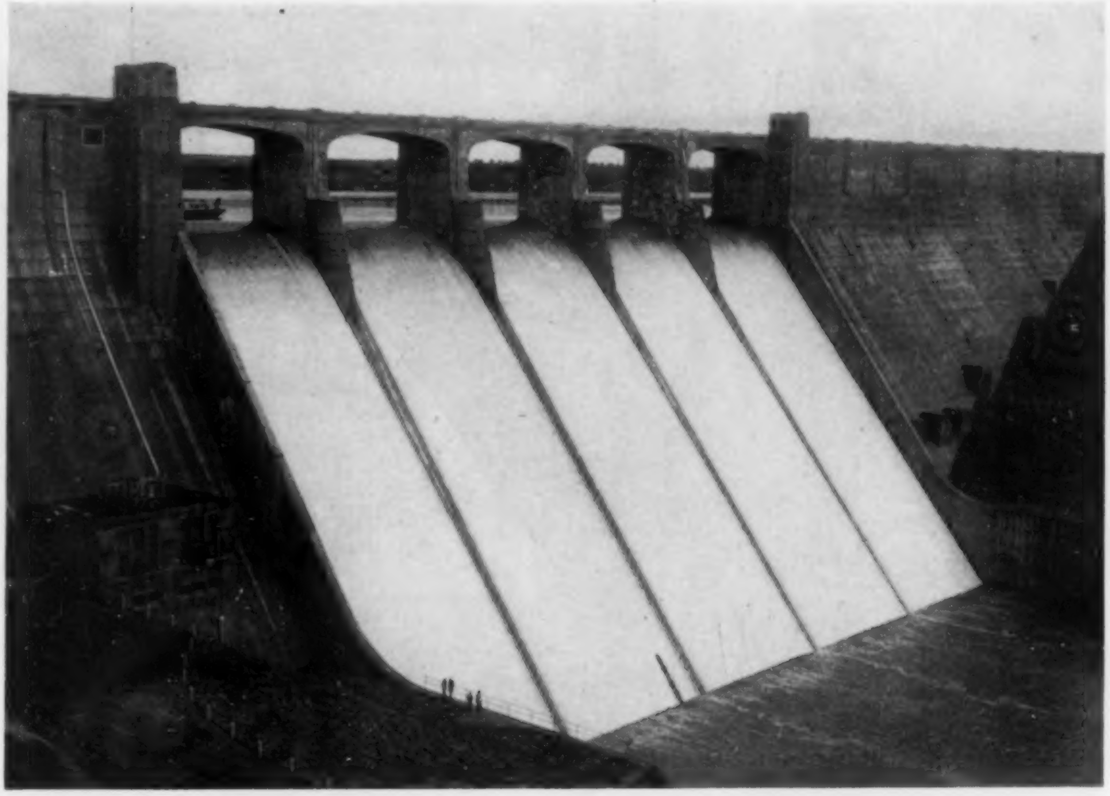
The Bureau of Reclamation obtains a specific appropriation for general investigations. Money from this appropriation is used to finance preliminary project and river basin studies concerned with determining the feasibility of a proposed undertaking. In its justifications to the Bureau of the Budget and to Congress, the Bureau furnishes a list of the areas or projects it proposes to examine, and following action by Congress the list is revised to conform to the funds made available. The Bureau receives in addition substantial advance contributions from states for investigations of proposed projects. Arizona has contributed $200,000 and other Western states lesser amounts.

Beginning with the fiscal year 1946, the TVA will obtain each year an annual lump-sum appropriation for the development of resources, capital improvements, and other assets, except direct power facilities and bridges over navigable streams. Included in the estimates for capital improvements and other assets is an item covering investigations for future projects. In its justification for its annual appropriation, the Authority indicates the areas in which its examinations for future work are progressing.

When a project has been authorized, the next step is to obtain an appropriation for its construction. The Corps of Engineers accomplishes this by including funds in the estimates for its annual appropriation, submitted after the authorization act has become law. The Bureau of Reclamation, in the same manner, includes a request for funds in the estimate for its annual appropriation after the Secretary of the Interior has found it to be a feasible project, or if Congress has passed a special act authorizing its construction. The TVA includes provision for a new project in its annual estimates, following approval of a proposed project by the Board of Directors. The requests of the Corps of Engineers and the TVA are on a lump-sum basis, but the estimates of the Bureau of Reclamation are submitted as individual project items.

The annual estimates of all three agencies are referred to the Bureau of the Budget in the fall of one year for the fiscal year beginning July 1 of the following year. Examiners in the Civil Works Section consider the justification supporting the estimates on the basis of current-year work-loads as related to long-term programs maintained by the agencies. Hearings are held with representatives of the agencies to explore more fully the details of the estimates of funds and related programs. Ad-

justments are recommended to eliminate conflicts or duplication between agencies and to keep development programs in step with one another. Recommendations prepared by the examiners are submitted to the Director of the Bureau for review. His action on the examiners' recommendations is submitted to the President in the form of a summary statement for each appropriation item. After change or approval by the President, the amounts determined to be proper are approved as estimates for the agencies, and their revised requests are incorporated in the Budget Document transmitted to Congress by the President early in January each year.



THE CONCHAS DAM IN NEW MEXICO WAS CONSTRUCTED BY THE CORPS OF ENGINEERS

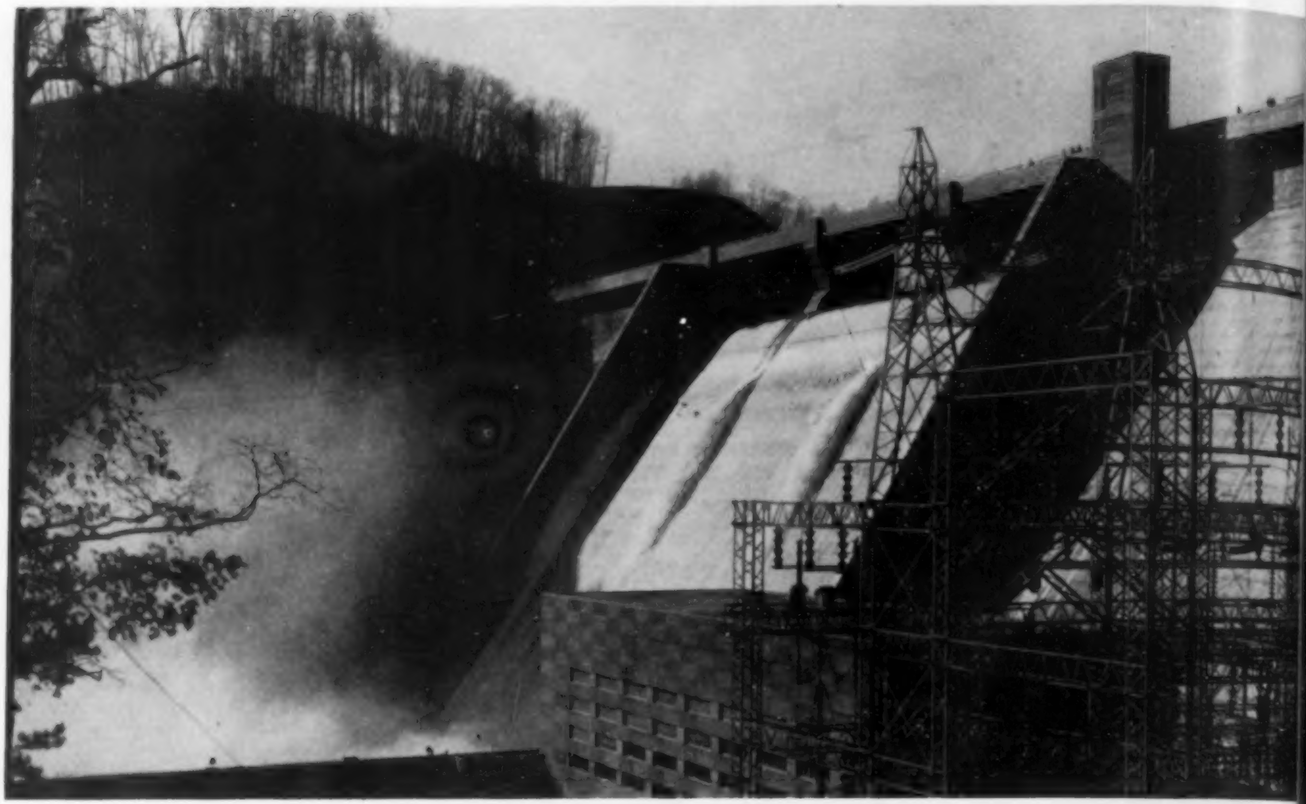
Hearings are subsequently held by the Congressional committees concerned. The Civil Functions of the War Department have a separate appropriation bill entirely distinct from the appropriation bill for the Military Functions of the department. The TVA estimates are considered with the various independent agencies of the government, and Congressional action on its request is included in the Independent Offices Appropriation Bill each year. Estimates of the Bureau of Reclamation are included with those for the Department of the Interior. Separate subcommittees of the appropriation committee in both the House and the Senate consider the estimates of the several agencies.

After passage of the annual appropriation bills, the agencies in July of each year submit to the Bureau of the Budget their estimate of the rate at which obligations will be incurred under the annual appropriations in the 12 months that follow. Their estimate is on a quarterly basis, and the examiners of the Civil Works Section, Bureau of the Budget, who processed the appropriation estimates originally in the preceding fall, again examine the agency's proposed rate of obligations. Money which it is apparent the agency will not obligate during the 12 months' period is placed in reserve for subsequent disposal. The Treasury is notified of the apportionment established by the Bureau of the Budget.

Financing of operation and maintenance of completed or partially completed projects follows a similar procedure. For the Corps of Engineers the lump-sum estimates for rivers and harbors and for flood control include an element for operation and maintenance of the constructed works. The Bureau of Reclamation justifies a separate operation and maintenance appropriation for each project, and this estimate in turn is subdivided between the operation of irrigation works and the operation of power plants, the latter being financed from power revenues. Some projects are operated with advanced funds, which are handled as trust funds, and are not subject to appropriation. The TVA includes provisions for operation and maintenance in the estimates submitted to Congress on the basis of the costs being met from power revenues.

With the exception of the Boulder Canyon project, there is no authority for establishing replacement reserves on any federal multiple-purpose project. It is not possible to accumulate funds either from revenues or from appropriations to meet future replacement needs. The TVA does have authority to use its revenues in the conduct of its business in generating, transmitting, and distributing electrical energy, and this has been construed to include replacement of electrical plant facilities. Such replacements are on an annual basis, however, and are not financed through the accumulation of reserves.

All financing for undertakings of the Corps of Engineers comes from the general funds of the Treasury. No power revenues are appropriated, and funds received from its power plants are deposited in the Treasury. Activities of the Bureau of Reclamation are financed in part from the reclamation fund, a revolving fund composed of revenues from power, irrigation, and other sources related to the public domain, and in part from the general fund of the Treasury. The reclamation fund finances the administrative expenses, general investigations, operation and maintenance, and construction of irrigation developments. Construction of large-scale multiple-purpose projects is usually financed from the general funds of the Treasury, but their operation and maintenance are met from the reclamation fund. The TVA conducts its program partly from appropriations and partly by utilizing revenues from the sale of power and from other sources.



NORRIS DAM ON THE CLINCH RIVER WAS THE FIRST PROJECT CONSTRUCTED BY TVA FORCES

Other federal agencies participating in the construction of multiple-purpose projects are the International Boundary Commission, United States and Mexico, the Bonneville Power Administration, and the Panama Canal. The Boundary Commission, under the Act of August 19, 1935, investigates proposed projects along the border, and those not international in character are approved by the Secretary of State and authorized by the President. International projects are authorized by treaty. The Bonneville Power Administration has full authority, subject to Congressional appropriations, to construct and operate all facilities necessary to distribute electrical energy. Major improvements to the Panama Canal are separately authorized by Congressional action, based on field reports of the agency.

Funds for the Boundary Commission for all purposes are included in the annual appropriations for the Department of State. The Bonneville Power Administration's funds appear in the annual appropriations for the Department of the Interior. As for the Panama Canal, it is included in the annual provisions for the Civil Functions of the War Department, consisting of an appropriation of general fund money and authority to expend revenues, excluding ship tolls.

### ENGINEERS IN BUDGETING

In processing estimates for appropriations, the same engineering personnel of all agencies participate to the extent of preparing the basic programs and collecting the supporting engineering data. They join with budget and finance officers in meeting the requirements of the Bureau of the Budget and Congress for the preparation of estimates in accordance with prescribed regulations. Hearings held by the Bureau of the Budget and the Congressional committees are attended by the engineering representatives of these agencies, who defend the justifications for the funds requested. The conception, design, construction, operation, and financing of the federal multiple-purpose projects are an engineering responsibility that will increase in weight and volume as the peaceful years of the postwar era witness the development and increasingly wide use of the Nation's water resources.

A BUREAU OF RECLAMATION PROJECT IS SHOSHONE DAM AND POWER PLANT, COMBINING HYDRO POWER AND IRRIGATION

# In at the Start at Panama

## *IV. Roosevelt Inspects; I Change Chiefs and Take My Last Job on the Canal*

*By the late* Frank B. Maltby, M. Am. Soc. C.E.

Early Division Engineer and Principal Assistant Engineer on the Panama Canal

*Most colorful of those great and near great who early came to the Isthmus was doubtless Theodore Roosevelt. His unpredictable excursions kept his entourage in constant trepidation. After a brief but constructive regime, John F. Stevens resigned as chief engineer, and Maltby was not long in following his example. Great credit, he believes, belongs to the Army engineers who then took over. But running through this last story of the series is Maltby's great admiration for his chief. He concludes with a glowing tribute to Stevens' genius and organizing powers.*

In the latter part of 1906 President Theodore Roosevelt made a visit to the Canal Zone. There is nothing I can add to the information concerning this great man except my own impressions of this visit. He was intensely energetic; he seemed to be able to carry on a conversation with me and dictate a cablegram to his secretary at the same time. He reveled in the publicity and commotion his visit created. He would make a speech at the slightest opportunity and without any preliminaries.

To begin the account of his unpredictable actions, it had been understood that the President would arrive on a certain morning. But the warship on which he was traveling sailed into Limon Bay the afternoon before. Of course there was a great scurrying about to get a special train ready, then to assemble the "brass collars" in Panama and Culebra and bring them to Colon to meet the President. Frederick Palmer, the great war correspondent, was dining with me that evening, and while we were at the table an orderly appeared with a note from the President, who was a personal friend of Palmer, asking him to come out to the ship. "Well," Palmer said, "that is one man you don't have to dress for," and when we had finished our dinner he put on his hat and walked down to the pier, about the time the special train came in.

It seems that among the party to make this official call on the President of the United States was the President of Panama. He suddenly discovered that he did not have the proper pants, and the whole party was held up while the city of Colon was searched for the necessary attire. Perhaps I should mention that this whole visit was the only event of its type which occurred while I was there for which I was not a member of the committee on arrangements. Hence I had no responsibility for details.

A small cannon had been secured from the Panama Army to fire a Presidential salute of 21 guns, and a lot of school children were to sing "The Star Spangled Banner" as the President came onto the dock. It had been arranged that he would land at 8 o'clock the following morning. At 7 o'clock I went down to the pier, only a few hundred feet from my house, to see that no one had obstructed the dock by tying up a coal barge and that nothing else was in the way of the Royal landing. I found only a few carpenters at work and everything in good order.

I had just turned to go back for my breakfast when around the point came a Naval launch carrying the Presidential flag, an hour ahead of time, with no one on hand to greet or salute the great man. He climbed up onto the dock and walked about talking to the carpenters—who did not seem greatly impressed. A messenger of course was dispatched to Washington Hotel a mile away, where the official party (including Secret Service men) were at breakfast. The latter had an attack of heart failure over the fact that the President was unguarded.

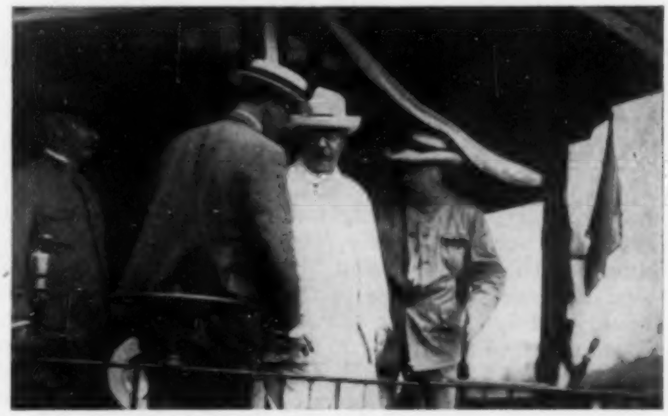
A few moments after the President arrived, George Shanton, Chief of the Zone Police, came onto the dock. He was a personal friend of the President from the "Rough Rider" days. Then the Panamanian Army arrived and fired a salute "after" the President was safely on American soil. Finally the school children arrived, lined up with their backs to the President, and sang their piece. (It wasn't their fault that the President was behind them instead of where he was supposed to be.) Meantime the "brass collars" were straggling in, breathless. I think some of them had their napkins still tucked in at their necks.

Finally all of them seemed to have collected and the disorganized mob of officials climbed aboard the special train, which had been backed onto the dock. But it did not start and the President became somewhat fidgety. Then a little man with flying, flapping skirts came galloping from the far entrance toward the train, which had started to move. Someone reached down and caught his coat collar and yanked him onto the back platform. It was the Bishop of Panama, the highest church dignitary in the Republic.

All I had to do was to enjoy the fun.

Don't think that I was not an admirer of "Teddy." But like other Presidents who have the "reform urge" he was first of all a politician and thoughtful of political ends.

One day at the Hotel Tivoli, in Ancon, after lunch he excused himself from his hosts—newspaper men and others—saying that he would retire to his room. Instead, he bolted out the back door, rushed up the hill to Ancon Hospital and into the wards, where he began talk-



Important Dramatis Personae on the Observation Platform of An Isthmus Train

From Left to Right, Col. W. C. Gorgas, John F. Stevens (Back Turned), President Theodore Roosevelt, and Theodore P. Shonts, Chairman of the Isthmian Canal Commission

JUNGLE SCENE ON BAYANO RIVER—OF TYPE FAMILIAR TO AMERICAN ENGINEERS

Boy in Front of "Cayuca" Is Holding Up a 30-In. Iguana, One of the Largest Lizards, and a Native Delicacy

ing to the patients as to their treatment and care. No one knew he was there until a nurse came in, as he had not announced himself nor asked permission to enter the wards.

He seemed obsessed with the idea that some one was trying to hide something from him. This action was a most unkind slap at Colonel Gorgas, who had been a member of his party all day and would have been proud to show him the hospital and everything he wanted to see. It was surprising, for the President was a friend and admirer of Colonel Gorgas and backed him up to the limit, even after he had retired from the White House.

Another day was spent in the Culebra Division, and I was not a member of the party. The President was photographed on a steam shovel grasping the levers fiercely and talking to a group of men. He was continually pointing to some feature and asking, "What's that?" "That is so-and-so." "Well, I want to see it." So the train stopped and the party waded through the mud to see possibly some outmoded sanitary device that had not yet been replaced with modern equipment. These incidents were made the most of by the anti-administration newspaper men.

That evening had been set aside for a meeting with division engineers and heads of departments. We had been warned to come loaded with information, as the President would want to ask a lot of questions. So we sat in the lobby of the hotel until after 11 o'clock while he listened to some steam-shovel operators. When they left it was so late, and he was so tired, that there was only opportunity for us to be introduced, shake hands, and retire—still in possession of all the information we had brought along.

### PINCH-HITTING AS MAJOR DOMO

On the last day of the visit, Mr. Stevens said, "Here, Maltby, you have got to head the procession today. I have blisters on both my feet and am worn out. Shontz is knocked out completely." On the train I was introduced to the President and Mrs. Roosevelt as the Division Engineer in charge of the Atlantic Division, who could explain all about the Atlantic end of the Canal. The first stop was at Gatun and we, together with three or four Secret Service men, charged up the hill as if we were taking a fort by storm. I suppose it was five minutes later that we were surrounded by a crowd of sixty to a hundred people. The President promptly dropped the inspection and made them a speech.

He was continuously stopping some black man and asking if he had any complaint or grievance. "No, except that we can't get yams." This was repeated several times. Yams, yams, yams! Finally the President asked me, "Why don't you give these people yams?" "Mr. President," I explained, "they do get yams, all they want, but just at the moment the supply is exhausted. A steamer will be here in a day or so and they can again have yams. They are not starving, but no Jamaican could ever resist an invitation to complain about something."

A reception was given on the dock at Cristobal that evening, the only public function held during his visit. I escorted the President and Mrs. Roosevelt to a small stand in the center of the dock so that the people could get all around him. Without any preliminaries I turned to him and said, "Mr. President, it is up to you." He immediately launched into a speech—and, as I remember, a very good one. At its conclusion, the people lined up and shook his hand. In a short time he left the dock and the Presidential visit was over.

Much to my surprise, disgust, and grief, Mr. Stevens told me overnight that he was going to resign. I spent most of the night in arguing and pleading with him in a vain effort to get him to change his mind. Finally he said, "Maltby, I know you pretty well now and without raising the question of your competence, if you were chief engineer you wouldn't last thirty minutes." "No," I said, "I wouldn't want it if I could get it." "Well then, why should I stay here?"

### WHY DID STEVENS LEAVE?

People have advanced many reasons for his resignation, which he said were all alike in one respect—they were all wrong. He accepted the position under protest and only after a considerable amount of persuasion. He did not expect to stay till completion. He told me that he had promised the President he would stay until the general plans were completed, organization and equipment provided, and the work well under way. He was to be the sole judge of when that time had arrived, and he thought it had come.

He was not a quitter. He could not have been driven off the Canal with a club if it were a question of fighting for what he thought was the right thing for the enterprise. He said his reasons were purely personal. Whether he had some plans, hopes, or aspirations for his life work I do not know. My own personal opinion—and I might as well have an opinion as all the others—is that he disliked notoriety very much. He disliked the limitations and restrictions placed on action in the Government service, and disliked being the subject of unlimited criticism from every whipper-snapper newspaper writer. He was used to handling large enterprises on his own responsibility, answerable to no one but the president of the road.

No criticism or disparagement of the Army Engineers is intended when I emphasize the amount of work done before the new organization took charge. They did not go through the dangers and privations of the early days. The improvement in sanitary conditions was under the Sanitary Division and I do not want to take away the slightest bit of credit from that Division. The Engineering Division cooperated in a wholehearted way to make the Isthmus a safe, healthy, comfortable, and pleasant place to live.

General plans of structures had been prepared, and plans for construction methods developed. Equipment had been secured, installed, and operated. Sources of material for constructing the locks, and equipment for securing it, had been found and furnished. The organization and personnel necessary for this vast enterprise had been secured, trained, and put to work—enough to

Towers and Cableways That Served Gatun Lock Construction—There Were Four Pairs in All, Erected by Maltby
View, Across Lock Site and Along General Axis of Gatun Dam, Shows Excavation Almost Completed and Concreting Started

demonstrate its fitness and efficiency. In other words, the new organization did not locate or build the road or buy the wagon or the mules, but when the road was well surfaced, the wagon inspected and greased, and the team broken in, they got up on the wagon and drove. And they drove very well.

Don't think I have any criticism of the Corps of Engineers of the Army. I belonged to the Corps myself for two years, and during my professional life I have served under 25 of the officers of the Corps. Don't think either that I mean to intimate that the new organization had nothing to do but turn over the wheels. The machinery had to be kept oiled and greased and fuel had to be provided. Facilities had to be expanded and new functions provided. Detailed plans were to be made covering all operating apparatus for the locks, the spillway, and the power plant; for relocation of the Panama Railroad and an elaborate system of docks at Cristobal; for a large drydock, machine shops, and terminal facilities at Balboa; and for endless other details.

No doubt mistakes were made in the $2^1/_2$ years of preliminary effort, but I never heard of any that were very serious. Stevens certainly did a good job. His resignation was submitted and accepted; and Col. George W. Goethals, M. Am. Soc. C.E., was appointed while I was in the States. I saw the Colonel in Washington just after his appointment and agreed to stay with him. I had known him slightly before; and our personal relations, not only on the Canal but later in private business, and even into the World War, were most pleasant. I returned to the Isthmus and we carried on; but naturally during this transition period we could not proceed with definite plans for the future.

### I TAKE A PARTNER

In June of 1907 I went to the States to make a final inspection of the *Culebra*, the first of the two seagoing dredges being built at Sparrows Point, Md., before its launching. I spent the week end in New York, and through mutual friends was introduced to a girl. To me she was the most wonderful person I had ever seen—absolute perfection in beauty, charm, and attractiveness. I was so much interested in her that I invited her to christen the dredge on the following Saturday. She accepted. There was also a young man who was more interested in the girl than in the launching. I was very proud of the christener. The young man lost any chance that he ever may have had.

When the Army Engineers took charge I was in the same position I had been in on the Mississippi River—a civilian charged with all the responsibility of building a plant and operating it efficiently, and of accomplishing results, while the rank and authority were held by Army officers. I don't know to what position I would have been assigned in the reorganization, but I know that I could not have retained the title of Principal Assistant Engineer, for no civilian could ever outrank an Army officer. Besides there was the girl. I resigned. Colonel Goethals treated me with the greatest consideration and refused to accept my resignation until I had reconsidered it.

My plans, specifications, and requisition for cableways finally were approved and bids for furnishing them erected, were advertised. Being no longer in Government service, I went to the Lidgerwood Company and told them that if I could be of assistance in the preparation of their bids I would be glad to do so. The offer was accepted with the understanding that, if they secured the contract, I was to go to Panama and erect the plant.

The bids were opened and Lidgerwood was low bidder. Three weeks after I had married "the girl," I left for Panama with the Chief Engineer of the Lidgerwood Company.

### CITY GIRL IN THE TROPICS

My wife had lived in a New York hotel for many years, and she had all the social graces, acquired through experience. To be with a roughneck engineer, and especially on the Panama Canal, was a radically new experience. She became very popular all the way down the line. Colonel Goethals gave her an annual pass over the Panama Railroad and Colonel Gorgas always danced with her at the Tivoli functions—and that dance constituted practically all of his participation for the evening. Wives of officials were very kind and my old employees, especially those from the Mississippi River work, tried to spoil her. Being the wife of a contractor with no official standing, she had no dignity of rank to maintain and could know anyone, but still enjoy the prestige of her acquaintance with the higher officials. She never had kept house and her introduction to tropical housekeeping—and more especially to giant cockroaches, iguanas, and coconuts falling on a tin roof—was somewhat startling.

When I first started housekeeping at Cristobal I had taken a Jamaican for a house boy. He was an undersized man about 55 years old, kind and attentive, and very courteous to strangers. He always called me "Chief," and was quite pompous and swelled up over his position. He was with me as long as I was there and became known all over the Atlantic Division as the "Chief's Charlie." As soon as we landed I ascertained that he was in Gatun. "Well, I want him," I said. So when the next train arrived Charlie came marching up to the house with all his earthly belongings in a big box on his head, and on top of the box his dearest possession, a feather pillow. The box showed his importance. Most Jamaicans would have had only a package wrapped up in a newspaper.

He immediately became the slave of "the mistress," and her protector against the cockroaches. It was the joy, delight, and amusement of the Cristobal colony and onlookers at the commissary to see her returning from market with Charlie, who was dressed all in white—shoes, trousers, coat, and cap—no color showing except his

ROOSEVELT PARTY ABOUT TO BOARD SPECIAL TRAIN ON THE PANAMA RAILROAD
In Group at Right Are President and Mrs. Roosevelt and Mr. and Mrs. Stevens

little black hickory-nut face. With a basket on his head, perhaps a bunch of bananas in one hand and feathers (live chickens) in the other, he followed exactly one pace to the rear and left. And she was so unconscious of it all—part of the new life of the wife of an engineer, which she was learning so rapidly.

Within a few weeks, and as soon as one was available at Gatun, a house was assigned for our use. In the meantime "the mistress" had acquired a laundress in Cristobal who came in by the day, and it was desirable to take her along to Gatun. The new house, however, had only one room for servants, so the mistress said, "Charlie, I wish you and Ann would get married so I could take both of you to Gatun." Charlie replied, "Mistress, I have mentioned that but Ann is married to God and is looking for nothing more." However, we cleaned out a large storeroom, so that we could put a cot in there for Ann. And that precious pair waited on us—even watched and prayed for the mistress every time she took a bath, fearing that she would catch cold—as long as we were there. We left them behind the gate on the Colon dock with tears streaming down their faces, begging to be taken along.

The erection of the towers started immediately, and as material and machinery came along promptly, there was no delay. This afforded me an opportunity that seldom comes to an engineer—that of building a plant he has designed and has faith in, and of demonstrating by contract his estimate of cost. The Government assisted in every way possible; the Panama Railroad employees were considerate and most obliging; my old employees were helpful in many ways. But the inspector on the job was not an old employee of mine, and in a good-natured way insisted on strict observance of the specifications.

When one pair of towers had been erected, I started placing machinery. The first piece I wanted was the foundation casting, and it could not be found though our shipping papers showed it had been checked off the ship. Now the foundation casting for a big 3-drum hoist cannot be lost or stolen or covered up. I got on a train arriving in Colon about 9 a.m. After some search I found the piece on a flat car at the extreme end of pier No. 2. I rushed to the train dispatcher's office. "Hey Joe," I cried, all out of breath, "there is a big casting on car No.— on the end of Pier 2. I need it damn bad as I cannot begin erecting machinery until I get it, and the men are waiting for it." He grabbed a telephone and called Cristobal. "Where is that construction train?" "On the siding waiting to follow No. 2—a passenger train—in about 20 minutes." "Give the conductor an order to get car No. — on the end of Pier 2 and take it to Gatun for Maltby." "Thanks Joe." "Don't mention it."

As train No. 2 was pulling out through the Gatun yard, the construction-train engine was shoving the car up the hill to the towers. By night the foundation casting was in place and bolted down. This was to me the most touching indication of the personal esteem and devotion of the men with whom I had formerly worked. The Division Engineer admitted that it would have taken him at least four days to get the car to Gatun.

### GREAT CREDIT DUE STEVENS

This review of my experiences on the Canal has emphasized to me the vast and impressive importance of the work done under Mr. Stevens' direction. He was a grand organizer and leader. Very early he realized that not only were sanitation, housing, and provisions for the wants of the employees important but, more than that, they were essential before any construction work, on a large scale, could be successfully prosecuted. And he did it.

The extreme importance of providing an adequate, suitable, well-designed plant cannot be overestimated. A mistake would have caused enormous delay and cost. Technically, Mr. Stevens was a transportation expert of recognized and outstanding ability, and no one could have been better equipped by experience than he to design the plant for excavating Culebra Cut.

He procured the mechanical equipment in the form of locomotives, cars, steam shovels, air compressors, drilling equipment, and the endless variety of tools and appliances, as well as the necessary shops and tools for the maintenance and repair of this enormous plant. Excavation of such large quantities involves the most important problem of transportation of the material. He personally made the layouts, not only for the tracks of the Panama Railroad but for the tracks serving the steam shovels, and their sequence of operations. These track layouts were among the most important tools in the plant and were very successful in operation.

One make or style of shovel might have been better than another, but certainly no one believes that an entirely different method of excavation or type of plant should have been used. One type of dredge might have been more efficient than another, but no dredge was a failure. The excavation plants, with those for procuring material and for placing concrete in the locks, built the Canal.

The personnel for operating the equipment was furnished and trained. To his successors were left the expansion and direction of operations and the detailed designing of fixed structures. This was all done, and exceptionally well done, by the succeeding administration.

There is plenty of credit available to go around to all those connected with the construction of this huge and wonderful enterprise. However, while admiring the completed and visible work, we should not forget the importance of the so-called preliminary work which made successful construction possible. As is the case with very many engineering enterprises, the real and important work is buried in and underneath the completed structure.

*[Other interesting experiences of Colonel Maltby are to be found in his complete manuscript, filed in the Engineering Societies Library. It is hoped that these printed samples will whet the appetites of many engineers to peruse the entire narrative. Thanks are tendered to H. W. Durham, M. Am. Soc. C.E., for permission to reproduce views from his extensive collection of Panama photographs.]*

# Prefabricated Barracks for the Army

By David F. Bauer

Architect, Special Projects Section, Structures Branch, Engineering Division, Office of the Chief of Engineers, Washington, D.C.

*Standard designs for prefabricated barracks were developed early in the war by the Army Engineer Board at Fort Belvoir, Va. Three classes were set up—metal, precut, and wood. In these three general divisions, many variations were accepted and used in every conceivable climate from Iceland to Tarawa. A detailed description of the various units and their adaptability is given by Mr. Bauer. It is entirely possible that many a soldier, won over by the adaptability and simplicity of his wartime home, will look to prefabrication to solve his postwar housing problem.*

Foxholes and tents are steps to the establishment of a base, but when it comes to buildings the Corps of Engineers is responsible for providing the housing, and often under conditions where economy of time is the primary consideration. Frequently local buildings and materials have been burned or demolished, new materials are too far away for quick delivery, and the weather and other conditions are adverse. The Corps of Engineers has solved the problem by providing ready-to-erect buildings in packages—packages not too large in weight or cubage to require special equipment for their movement but easily handled by small crews of men, and providing protection for their contents in overseas shipment and taking up the minimum of shipping space. Assembly of such material into buildings is within the limited construction knowledge of the average soldier.

The sudden precipitation of this country into the present conflict and the global extent of operations created a demand for outposts in many places, requiring an immediate provision of some type of shelter. Available 16 by 16-ft huts and larger barracks were purchased direct from the prefabricators and were of their own design. Wood, plywood, and metal buildings of square, pyramidical, or semicircular shapes were secured in nearly every state in the Union and shipped immediately. Nissen huts from the British Isles were sent to Iceland. The advantages of any type were not the prime consideration, but rather the speed with which it could be secured.

As it became known that the Army was considering prefabricated buildings, many schemes, suggestions, models, and plans poured into the Office of the Chief of Engineers from individuals, manufacturers, and inventors. These suggested designs—ranging from two-man barracks to large storehouses and hangers—varied in shape, material, assembly, method of erection, and included practically all possibilities. Each scheme submitted was given due consideration.

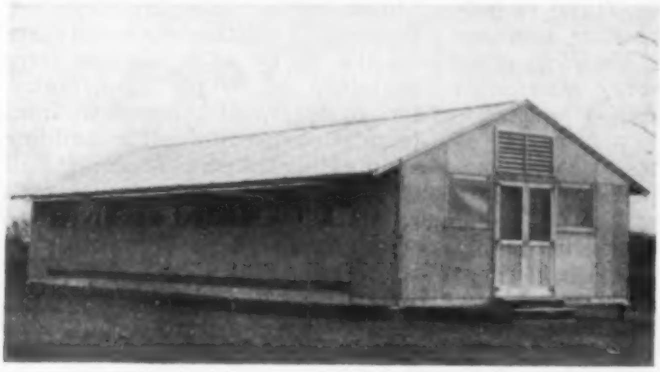
Many manufacturers cheerfully and without cost to the Government submitted pilot models of their buildings for test by the Engineer Board at Fort Belvoir, Va. These buildings were erected by troop labor under simulated theater conditions, and tests were conducted according to a prescribed procedure, for the purpose of determining ease and time of erection, demountability, structural stability, and shipping cubage. Every design was analyzed and reported on by means of a basic form, with results as varied as the designs. From these data the Office of the Chief of Engineers developed standard designs of the types which research and tests had established as within military needs and policies for overseas use.

The first standard design for barracks was chosen on the basis of speed of manufacture. In 1942 many mills were available, plywood was plentiful, and a building in sections permitted quick and easy erection. A plywood building was selected and drawings prepared for "Insulated Barracks, Prefabricated, Plywood." All the component parts for this 20 by 48-ft barracks were contained in 40 packages, crated for overseas, and complete from foundations to roof. The building rests on wooden posts supporting the panel floors and wall panels. The latter are about 7 by 8 ft, complete with screens and windows, and are fastened to the floor and to each other by means of lag screws. The roof panels are supported on separate trusses and anchor-tied to the supporting members. Battens cover the roof joints. Then, with the installation of electric wiring and hardware, the building is ready for occupancy. However, the cubage and weight of this type of building was found to be excessive and it was replaced by the "precut" type.

A design was developed with a hard-board exterior finish employing the gothic-arch principal, which provides more floor space than the semicircular shaped Nissen huts. The building was designed to use a minimum of steel ribs of light gage, channel shaped, for the framing of the floors and walls. The floor was of plywood sheets and the exterior finish was nailed into place on wood spacers between the steel ribs. An interior finish was held in place by a "clipped on" connection and battens. Alternate standard plans were also prepared of the same design providing for the use of a covered corrugated metal, or of galvanized corrugated sheets. The design for the galvanized corrugated sheets also incorporated metal spacers in lieu of wood; this therefore was an all-

"Pacific" Type Huts at Attu Station

EARLY TYPE OF PLYWOOD SECTIONAL BARRACKS, INSULATED



LATER TYPE OF PLYWOOD "PORTABLE-PRECUT" BARRACKS FOR TROPICS

INSULATED INTERIOR OF A METAL CHANNEL-FRAME TYPE

EXTERIOR OF THE METAL BARRACKS SHOWN ABOVE

metal building with the exception of the plywood floor and interior finish. None of these buildings were procured, as an immediate need for overseas hospitals arose and the requirements of the Office of the Surgeon General precluded the use of any but straight-sided buildings.

Present standard designs are grouped in three classes—metal, precut, and wood—and there are two types of each, a tropical design and an insulated. The tropical design embodies such features as continuous windows, ventilators at the base of the side walls, and eave overhang, whereas the insulated designs have a minimum of windows, gable or ridge ventilators, and an interior lining of insulating material. The requirements also necessitated a scheme for expanding buildings from the basic 20 by 48 ft length to any length up to 120 ft so as to provide related functions and facilities under one roof. This was accomplished by packaging separately complete parts of a building to form an 8 by 20 ft unit, which could be inserted between the ends of a basic building. These separate units, when required, contain windows for both sides of the building or doors when exit is necessary at the sides. By this means it was possible to successfully plan buildings for any size of hospital. Thus in a 500-bed hospital, 68 basic 20 by 48-ft buildings, 253 "B" units with windows, and 77 "C" units with doors, are furnished.

## FEATURES OF METAL BARRACKS

The "Barracks, Portable, Prefabricated, 20 by 48-ft Steel (Angle Frame) for Tropical Use," was based on the design of an earlier 20 by 50-ft insulated steel building, but incorporating the requirement of a tropical design, plus other improvements as developed by experiment. The building requires no structural shapes but is all sheet-type metal from 12 to 24 gage, bent to form angles and other required shapes. The foundation posts, wall studs, and roof rafters are angle shaped and are covered by flat metal sheets which are formed along the sides to fit over the angles. These are fastened together by bolts which pass through the edges of the covering and through the angle wall studs and, when drawn up tight, make a weather-proof joint. The interior finish consists of a plywood floor, a wall and roof lining of a light cream-colored board; these are easily installed and conducive to pleasant living conditions. The building is packaged in 34 packages. The light gage of the metal and the easy nesting of angles, sheets, and forms, one into another, make the required shipping space and the weight of the packages comparatively small. Erection procedure permits some pre-erection assembly and is rapidly accomplished with speed bolts and sheet-metal screws.

The insulated design for the same type of metal building is also based on the earlier 20 by 50-ft building. The latter was discontinued and redesigned as a 20 by 48-ft building to permit 8-ft sections to be used as a module. In the redesigning it was possible to reduce the steel required by approximately 15%, thereby saving not only material but also shipping space and weight in packages.

In order to utilize the facilities of other steel fabricators who were not in a position to fabricate angle-shaped members, the Office, Chief of Engineers, designed two other steel buildings of this size, employing channel-shaped framing members. The tropical design incorporates continuous side windows, wall and ridge ventilators, and eave overhang. The temperate design meets only the minimum ventilation requirements. Both buildings provide for "B" and "C" units. The salient features of these buildings are the use of channel-shaped framing members, corrugated sheets inserted between the framing members and held in place by the use of clips, an exterior sliding steel sash operated by a chain

"Main Street" in an Iceland Camp of Nissen Huts

through the window head, a plywood floor, and cream-colored interior wall finish. Erection is simple, as the framing members form a continuous rib from footing to ridge, and the insertion of the corrugated panels by slightly spreading the ribs at the eaves is a simple operation. Sheet-metal screws and bolts are used to fasten members together. The interior finish is applied and held in place by battens clipped to a button-type fastener.

Further research regarding buildings for tropical use, utilizing wood and plywood, led to the development of a standard design of a "precut" or "ready-cut" building. All the component parts of this building are factory fabricated to proper size and length, provided with necessary holes for bolting, notched and grooved to assure that various parts will be properly placed, and cut to fit without any field adjustment. This building is classed as a plywood building, rests on wood posts, and has a plywood floor, walls and roof. Continuous windows, ventilators at the base of the side wall, gable ventilators, and eave overhang characterize this design.

No interior finish is furnished, as the plywood presents a pleasing wall, but for hospital purposes wallboard is supplied for rooms where required, under a bill of materials and is sent separately. The complete 20 by 48-ft building is shipped in 21 packages, and at a saving of approximately 50% in shipping space and 12% in overall weight over other plywood buildings. Erection is accomplished by first assembling the parts into sections or units, and then placing the sections in the building by means of bolting and double-headed nails. The building can be dismantled and moved for re-erection in sections. The "B" and "C" units for 8-ft sections were also designed for this building and packaged separately.

The "Insulated Precut Building" meets the requirements for an insulated building and has the general characteristics of the tropical except that the insulation, as well as the roofing material, is included in the packages. Insulation is applied to the interior face of the studs and the under side of the roof rafters. The roofing material is provided as a protection to the plywood against snow and other adverse weather. The addition of the insulating and roof material increases the number of packages to 31, but increases the cubage only 9%.

The complete 20 by 48-ft insulated all-wood building was designed to be contained in 47 packages. The nesting of the 4 by 8-ft panels within each other reduced the required shipping space to a minimum for a sectional-type building. The building rests on wood posts—treated to resist moisture and fungus—which support the sectional floor panels bolted together. Side and end walls are also in panels, some of them being blank or completely covered with siding, and others having windows. The interchangeability of the side-wall panels permits variations in plan. The roof is also in panels which, with the addition of proper wood ties, become a part of a truss. A type of rolled roofing is applied separately in the field. However, in case of re-erection this roofing is permitted to remain in place, cut along the panel points, and later re-covered by strips of the same material. The entire building is insulated by the application of insulating material between the joists, studs, and rafters.

Erection is simple, as all the sectional panels are fastened one to another by means of bolts and double-head nails, which also permit easy disassembly and re-erection. The tropical design has the general characteristics of the insulated building but incorporates tropical requirements.

Shipping space for these two standard buildings, although considered the minimum for the sectional types, is between 700 and 800 cu ft. As shipping space becomes a greater factor, along with the critical shortage of lumber, the procurement of these types is very limited.

### NEUROPSYCHIATRIC WARDS

The need for a substantial prefabricated building for neuropsychiatric patients resulted in the designing of an all-steel building in a group or unit based on the "Steel (Angle Frame) Tropical." The complete unit for 60 patients consists of two wards, 20 ft by 128 ft each, with one smaller building, 20 by 32 ft for utilities, and one building 20 by 24 ft for kitchen and offices. The group of buildings is connected by prefabricated metal corridors and has an enclosed exercise yard formed by the rectangle. The component parts are angle-shaped posts, angle-shaped uprights and roof rafters, all covered on the outside with flat sheet metal. The usual tropical features

PORTABLE PREFABRICATED BARRACKS OF STEEL ON AN ANGLE FRAME FOR USE IN TROPICAL CLIMATES

A SECTIONAL ALL-WOOD BARRACKS, INSULATED FOR USE IN A RIGOROUS CLIMATE

are incorporated in the designs, and the interior finish, including partitions for the wards and utility buildings, is also metal—factory fabricated. The metal interior finish of the outside walls is grilled to cover the windows and ventilators and is installed as the building is being erected, but the metal room partitions can be installed later. Ample ventilation is assured by the use of wire grilled ceilings, which also permit the placing of lights beyond the reach of patients. In fact all screws, bolts, and fastenings are concealed or of a special type to prevent tampering with by patients, and every precaution is incorporated to prevent self injury. The floors are plywood in the office and kitchen building; in the wards this plywood floor is covered with tightly stretched and impregnated canvas for sanitary reasons.

The floor in the utility building is a light concrete poured into formed metal sections, which will permit disassembly without destruction of the floor. Insulation of a "sprayed-on" type is provided on the side walls and partitions as a sound deadener, while under the roof is insulation of the blanket type supported by chicken wire. Piping and plumbing fixtures are all prefabricated, ready for installation. Some cabinets are also furnished, prefabricated and ready for assembly and installation.

It is planned to assemble this building completely, including all equipment and material, as a unit in this country, under the direction of an officer who will then accompany the material overseas to a selected site and supervise its reassembly. Its assembly requires planning and precautions because of the necessity of placing all members in the proper position as construction proceeds.

At the request of one of the theaters of operations, a "Building Shell, Prefabricated," 20 by 54 ft, was designed to provide only the minimum in framing and corrugated metal covering. All the material is packaged in one bundle. The wood framing ribs are precut to size, easily assembled with bolts, and spaced approximately 9 ft on centers. The roofing and the exterior covering on the side walls, only 4 ft in height, are of corrugated metal sheets. Floors, windows, doors or finish are not provided, but may be installed from materials available locally. The simple erection is accomplished by forming the ribs on the ground, raising them, and inserting the purlins and girts into metal clips on the ribs. The purlins are designed with a $^3/_4$-in. cut-out to accommodate insulation, when required, by the simple operation of inserting them upside down in the clips. The spanning of the corrugated sheets on the purlins and girts completes the erection.

The material packaged in the "Insulating Kit" is sufficient to inclose this building completely and in such a manner that the general requirements for a tropical building are attained. The package contains the doors, windows, screens, and insulation material (which is placed under the roofing only). A concrete floor makes the completed building very livable. With the application of interior finish, the structure can be used for hospital purposes. The combining of buildings would provide doors for side egress where required.

A warehouse for the same theater of operations, 110 by 405 ft in size, was also designed with the minimum framing and covering. This building may be varied in length, and to provide for such variation each bay is packed complete in one package. Thirty-one packages are required for a 405-ft building. The material for the covering of the ends is obtained from the excess lumber inserted for that purpose in each package.

In planning a hospital layout for 250, 500, or 1,000 beds, the use of "B" (window) and "C" (door) sections permits an arrangement or typical layout by which the facilities can be doubled or quadrupled merely by adding other buildings to the functional group. Sufficient distance is allowed between buildings to make such additions possible as required. Wards can be added by extending the corridors to the right and left.

### BUILDINGS OF SPECIAL SHAPES

At an overseas project where "Steel 20 by 50-ft Angle Frame Buildings" were available, it was determined to create longer buildings and also buildings of special shapes. A unit was planned to consist of two buildings 110 ft long with a 30-ft-long lavatory building between, and connected by a covered walk. The entire unit was equivalent to the material in five packages, each of the 20 by 50-ft building type. Ten feet of building from the lavatory structure was inserted between two standard buildings to form the 110-ft structure. The only field fabrication required was the making of two pairs of clip angles and the assembly of one additional truss from the excess end framing. Where T-shaped buildings were desired, a simple connection of the side walls was designed, and the space between the roofs was filled in with wood and covered with material from the excess ends. The erection was accomplished by untrained labor, and in one week a crew was erecting a building in less than two-thirds of the time required for the first one.

As the standard designs are now stockpiled by the thousands, are listed as available in the "Engineer Supply Catalogues," and have proved their merit through actual use, the possibility that new designs will be adopted is slight. Of the numerous designs still being submitted, none have been shown to be an improvement over the standard designs, considering the numerous requirements that must be met.

# Engineers' Notebook

*Suggestions and Practical Data Useful in the Solution of a Variety of Engineering Problems*

## Fog Lifted from Airfields by British Development

*By* A. C. Hartley

Technical Director, Britain's Petroleum Warfare Department

In December 1944 a squadron of bombers took off from an airfield in England when the visibility had been cut to about 100 yd by a fog blanket. Returning from a successful mission, they landed safely when the visibility of the area was only 50 yd. One of aviation's worst enemies—fog—had been demonstrated to be impotent.

To accomplish this seemingly impossible feat, the runway is converted into a huge brazier whose heat lifts fog in the area over and adjacent to the landing strip.

A Pipe Line Surrounding the Runway Creates a Band of Flaming Gasoline

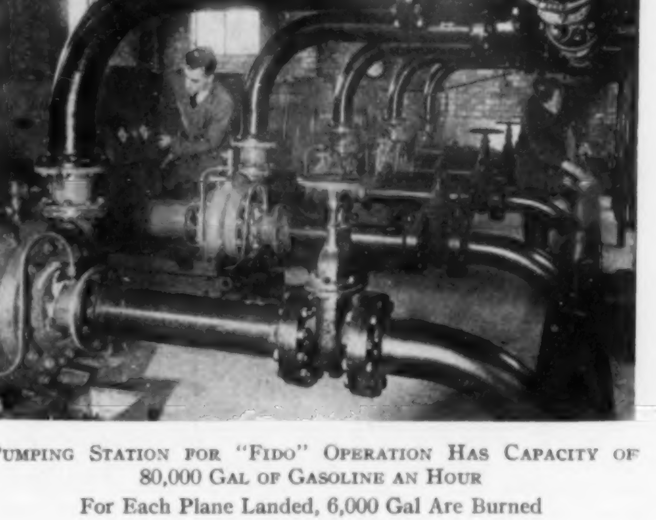
This operation, developed by British engineers, meteorologists, scientists, and pilots, is called "Fido," standing for Fog Investigation Dispersal Operations. In a race against time for the lives of Allied pilots, many experts were brought together, and charged with finding a solution to the perplexing problem, sparing no cost. The objective set was to clear of fog a space 1,000 yd long by 150 ft wide to a height of 100 ft, 500 yd of the cleared space to be in the approach and 500 yd on the runway.

Research and experiment went on simultaneously. The methods considered included the use of supersonic waves, electrical discharges, absorption of moisture by chemicals, drying by refrigeration and outdoor air-conditioning apparatus. From the outset, however, the dispersal of fog by heat promised the greatest success. Fog chambers were erected and large-scale heat-producing installations assembled in fog-ridden districts while Royal Engineers constructed and manned a special mobile installation to be sent wherever fog was reported. The first success came on November 4, 1942, when on Moody Down, Hampshire, a fog of 50-yd visibility was cleared by petroleum burners in an area 200 yd square to a height of 80 ft. The same day an even denser fog was cleared at Staines, down wind of a line of braziers burning hundreds of tons of coke. Parallel experiments proved petroleum more successful than coke, though it produced more smoke. It lit up quicker, involved less manpower, and could easily be piped to the site by linking the countrywide network of pipe lines.

By January 1943, experimental large-scale runways had been constructed to which the Fido team hastened whenever they received special fog warnings—usually in the small hours of the morning. It was discovered that if the heat of the atmosphere could be raised 7 F, the fog disappeared. This heat is provided by a continuous line of petroleum burners installed parallel to, and some distance from, each side of the main runway. The height of the clearance depends upon the wind and the moisture content of the fog. In extreme conditions, such as cloud or sea fog and high winds, it is difficult to get good clearances up to 100 ft, but in calm weather with radiation, fog clearances of over 500 ft have been obtained.

Standard fog-dispersal installation consists of three main portions—burner lights, pumping and distribution, and storage. On the initial light-up, much smoke is created, but this quickly clears as the petroleum vaporizes. In normal conditions, the fog can be cleared in 10 minutes. It has been cleared in 6 minutes. When intersecting runways are crossed, a burner pipe sunk flush with the ground is necessary to avoid obstructing the aircraft. This is supplied by a separate vaporizing unit. The main fuel-handling pumps are six gasoline-engine-driven centrifugal pumps connected to the supply main from the storage tanks. The petroleum is stored in steel tanks. The installation is manned by one R.A.F. sergeant, three corporals, and 17 aircraftsmen. It is estimated that "Fido" used up 100,000 tons of gasoline in $2^1/_2$ years—6,000 gal per aircraft landed.

The first experimental operational installation was erected on a Pathfinder airfield in February 1943, though it was not tested out in the fog until July 17, 1943, when visibility fell to between 100 and 200 yd. "Fido" restored



Pumping Station for "Fido" Operation Has Capacity of 80,000 Gal of Gasoline an Hour

For Each Plane Landed, 6,000 Gal Are Burned

full visibility on the runways for 1,300 yd. An aircraft took off and landed four times, and "Fido's" future was assured. It is now established on a number of airfields in eastern and southern England, including the Suffolk rescue station, where hundreds of lame and disabled planes, American as well as British, were brought in. Fido was not installed on any American station, but the U.S.A.A.F. frequently used R.A.F. airfields when fog made landing difficult.

One U.S.A.A.F. Marauder pilot lost in the fog saw the glow caused by a "Fido" on trial and was able to land safely. "I couldn't have landed without it," he said. "I had tried eight times already and I know."

After months of experiment, "Fido" was brought into operational use on November 19, 1943. On that day, four Halifax bombers landed successfully on returning from the Ruhr, when the surrounding visibility of the airfield was only 100 yd, because 10 minutes after "Fido" had been lit, visibility on the runway increased to the equivalent of from 2 to 4 miles. Since then over 2,500 Allied aircraft have landed safely—often in dense fog—with their crews of over 10,000 airmen. "Fido" has frequently assisted American airmen. On one day no less than 91 U.S.A.A.F. aircraft landed at one installation.

About 500 men composed the "Fido" team, including scientists, a departmental staff of about 50 Royal Engineers, who had the distinction of making the first fog clearance in Hampshire, about 40 R.A.F. ground staff, engineers, and contractors' men. The Bomber Command loaned experienced pilots and meteorologists.

# A Graphical Solution of the Secant Column Formula

*By* DAVID H. CRATER, JUN. AM. SOC. C.E.

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THE secant formula for the solution of eccentrically loaded columns may be solved by the use of certain approximate formulas and other analytical methods. A graphical solution of the formula is here presented in the form of a logarithmic chart to solve for steel columns loaded either axially or eccentrically. A solution is given for three kinds of steel (structural, silicon, and nickel) using four types of assumed end conditions (commercial riveted, commercial pinned, theoretical fixed, and theoretical pinned). These materials and end-condition factors are those specified by the American Railway Engineering Association and the American Association of State Highway Officials.

This method offers a rapid and accurate solution in which a trial value of the allowable working unit stress in the column is estimated and checked by the chart. Usually three or four estimated values are necessary to obtain a check to the desired accuracy. The discrepancy between the final chart value and the value from the solution of the secant formula is considerably less than 1% except in columns with high slenderness ratios.

If desired, the chart may be used to obtain only an accurate estimated value of the allowable unit working stress for checking in the secant formula.

### FORMULA SEPARATED INTO TERMS

The secant column formula is generally stated:

$$\frac{P}{A} = \frac{S}{1 + 0.25 \sec\left(\frac{NL}{2R_1}\sqrt{\frac{f}{E}\frac{P}{A}}\right) + \frac{e_1c_1}{R_1^2}\sec\left(\frac{NL}{2R_1}\sqrt{\frac{f}{E}\frac{P}{A}}\right) + \frac{e_2c_2}{R_2^2}\sec\left(\frac{NL}{2R_2}\sqrt{\frac{f}{E}\frac{P}{A}}\right)}$$

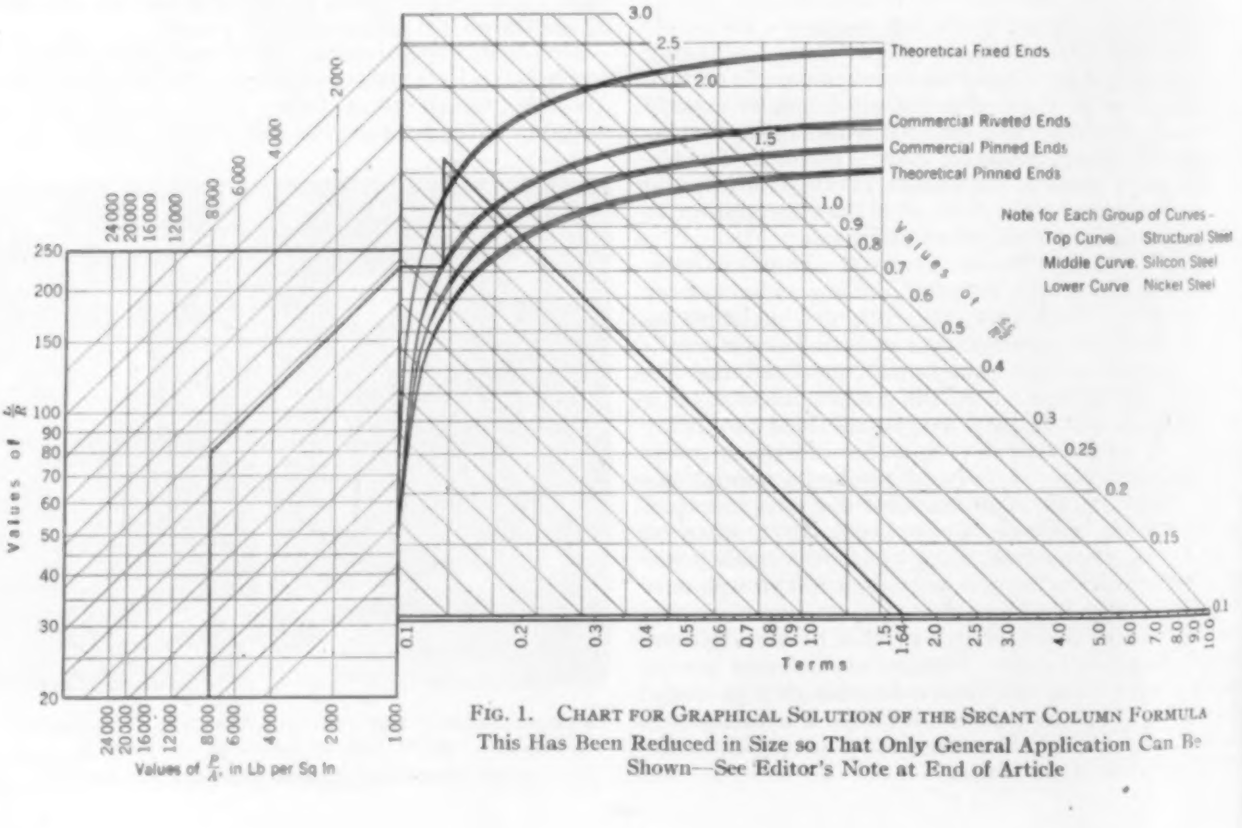



FIG. 1. CHART FOR GRAPHICAL SOLUTION OF THE SECANT COLUMN FORMULA

This Has Been Reduced in Size so That Only General Application Can Be Shown—See Editor's Note at End of Article

in which

$P/A$ = unit working stress in the column
$S$ = allowable unit working axial stress
$N$ = end-condition factor
$f$ = factor of safety based on unit stress at yield point
$L$ = unsupported length of column
$E$ = modulus of elasticity; for steel = 29,400,000 lb per sq in.
$R_1$ = least radius of gyration
$R_2$ = radius of gyration at right angles to $R_1$
$e_1$ = eccentricity of load in direction of least radius of gyration ($R_1$)
$e_2$ = eccentricity of load in direction of greater radius of gyration ($R_2$)
$c_1$ = distance from neutral axis to extreme fiber in direction of $R_1$
$c_2$ = distance from neutral axis to extreme fiber in direction of $R_2$
0.25 = coefficient providing for inherent crookedness and unknown eccentricity

Values used in the construction of the chart follow:

| MATERIAL | $S$ | $f$ |
|---|---|---|
| Structural steel . . . | 18,750 lb per sq in. | 1.76 |
| Silicon steel. . . . . | 25,000 lb per sq in. | 1.80 |
| Nickel steel. . . . . | 30,000 lb per sq in. | 1.83 |

| END CONDITION | $N$ |
|---|---|
| Theoretical fixed ends . . . . | 0.50 |
| Commercial riveted ends . . . | 0.75 |
| Commerical pinned ends . . . | 0.875 |
| Theoretical pinned ends . . . | 1.0 |

### USE OF CHART

The chart, Fig. 1, is used for columns loaded eccentrically about either or both axes of symmetry. The secant formula is in the form:

$$\frac{P}{A} = \frac{S}{1 + \text{Term A} + \text{Term B} + \text{Term C}}$$

"Term A" provides for inherent crookedness and unknown eccentricity about the axis of least radius of gyration with $ec/R^2 = 0.25$. "Term B" and "Term C" provide for known eccentricity of the load about the axes of symmetry.

This chart also may be conveniently used for axially loaded columns in which the secant formula would simplify to

$$\frac{P}{A} = \frac{S}{1 + \text{Term A}}$$

For solution of a typical problem the following procedure should be used:

1. Estimate the value of $P/A$.
2. Enter the left half of the chart at the estimated value of $P/A$ and run vertically to the intersection of the $L/R$ value for "Term A."
3. From this intersection follow the direction of the lines inclined at 45° upward to the right, arriving at the vertical line near the center of the chart.
4. From this vertical line, run horizontally to the secant curve representing the end condition and the material used.
5. From this intersection, run vertically (either upward or downward) to the horizontal line representing the $ec/R^2$ ratio for "Term A."
6. From this intersection with the value of $ec/R^2$ follow in the direction of the lines inclined at 45° downward to the right, arriving at the value of "Term A" in the lower right of the chart.
7. In like manner repeat Steps 2–6 inclusive for the other "terms."
8. Divide the allowable unit working axial stress ($S$) by 1 plus the sum of the "terms" to obtain a value for $P/A$.
9. Compare this value of $P/A$ with the originally estimated value, estimate a new value of $P/A$, and repeat Steps 2–8 inclusive until the value determined from the chart agrees sufficiently closely with the estimated value.

Two things are to be noted, in connection with the steps just outlined:

1. To facilitate the solution of eccentrically loaded columns, combine "Term A" with "Term B," using the sum of the coefficient, 0.25, and $e_1c_1/R_1^2$ for the constant, $ec/R^2$.
2. For axially loaded columns, Step 7 is omitted because it is necessary to determine "Term A" only.

EDITOR'S NOTE: *Because of physical limitations, the full-size working chart cannot be printed in "Civil Engineering." Those desiring a print of the full-size chart, which can be used for the solution of all the problems to which this method applies, can obtain the print for 25 cents from Society Headquarters.*

# Our Readers Say—

*In Comment on Papers, Society Affairs, and Related Professional Interests*

## River Valley Authorities Defended

DEAR SIR: In the article entitled "Proposed Substitute for River Valley Authorities," by Messrs. Stevens and Horner, which appeared in the April issue, there are raised a number of issues that should be more thoroughly discussed.

Consider, for example, the statement that an Authority is "decidedly undemocratic"—"a federally sanctioned dictatorship," presumably because its direction is in the hands of a small group of people "appointed by the President with no direct responsibility to the people of the basin." On that basis there are no federal executive agencies that would be classed as democratic. It is common knowledge that the heads of all federal executive agencies are appointed by the President and are responsible to him. The only exception that comes to mind is the independent regulatory commission whose members are appointed by the President. It has never been finally determined to whom such a commission is responsible, although the trend in recent years has been to make it responsible to the President. As no executive agency is directly responsible to the people, why do the writers single out Authorities for criticism on these grounds?

As engineers, Messrs. Stevens and Horner probably base their criticism of the "Authority principle" on evidence gathered by them in the only area where an Authority is in operation. Are they saying, by implication, that the Tennessee Valley Authority is a dictatorship? Possibly some testimony in that connection should

be taken from people living in the Tennessee Valley. The most recent public expression on the TVA came in response to Senator McKellar's attempt early this year to change one part of the Authority's basis of operation. The people of the Valley approve of the TVA as it is and strongly opposed making any change in it. They would have been quick to support Senator McKellar's proposal if they had been living under a dictatorship—no one has ever accused the residents of the Valley of lacking in courage.

Judging by the record as it exists in a multitude of investigations and studies by critics, the only existing Valley Authority in no way corresponds to the picture drawn in the article. Why should future Valley Authorities function in the manner implied by the writers?

A summary of the operation of the proposed "Basin Development Councils" uncovers several weaknesses. As proposed by the writers, such a Council would have the responsibility of planning the coordinated development of a river valley but would have no authority to take positive steps to accomplish this, or even to say what is to be done first. From two to, possibly, twenty agencies would construct the various dams, power plants, irrigation canals, and other engineering structures in any sequence and using whatever standards they desired. As proposed, the Council would appear to be more of a debating society for the representatives of a score of federal and state agencies (and sundry miscellaneous individuals), than a coordinating and planning board. Differing social viewpoints of the various individuals composing it, if nothing else, would make a coordinated approach to basin development well-nigh impossible.

It is, indeed, surprising to find engineers publicly advocating that such a mixed group try to integrate important engineering construction; proposing in effect, an agency which would have responsibility for obtaining results and no authority to carry out its plans. All this in the face of a decade of successful planning and construction; authority to do the job and responsibility for getting the job done; singleness of purpose, yet decentralization of administration as demonstrated in the Valley of the Tennessee.

With all due respect for the eminent engineers who proposed Basin Development Councils, I believe that the success of the Valley Authority Principle in the Tennessee Valley indicates that coordinated river basin development under a single Authority is a most desirable way to proceed in the future.

RAPHAEL G. KAZMANN, Assoc. M. Am. Soc. C.E.
*Memphis, Tenn.*

## We Must Seek to Improve Our Status

TO THE EDITOR: After reading Mr. Girand's provocative article on the "Status of the Civil Engineer in Modern Society," in the June issue, I was profoundly moved by certain facts that he has revealed about the profession. As a Junior in the Society, I feel the present social and financial status of the civil engineer to be disheartening; and to one contemplating entry into our profession, I should think it might seem almost prohibitive. It is deplorable that the outlook for civil engineers isn't brighter because, under the circumstances, how can we expect to attract the more talented students to our profession?

Mr. Girand has succinctly pointed out that the civil engineer, by the very nature of his work, is not in a position to profit from it financially. Furthermore, the fact that so many engineers are government employees accounts for the pitifully low scale of remuneration. To his suggestions for improving the status of the engineer, I should like to contribute another. In addition to restricting the number of engineers through examination and lobbying for increased legislative appropriations, the level of salaries may be appreciably elevated if older engineers who are in a position to hire other engineers will insist on more respectable salaries for their subordinates. When engineers in positions of responsibility are content to be underpaid, those under them must suffer correspondingly. It is my contention that the deflated financial status of the civil engineer has to a marked degree been created by the profession itself.

My second point is that a civil engineer must truly merit increased remuneration. He must have received such a thorough training in the art of engineering that, through increased usefulness, he will be more valuable to his employer. It is fitting, therefore, that many engineering schools are revamping antiquated curricula at this time with the thought of making postwar engineering training the best possible.

While I thoroughly agree with most of Mr. Girand's article, I should like to take objection to his statement that "The status of the civil engineer in modern society is satisfactory." How can that statement be reconciled with the low financial and social status which he has so clearly pointed out? A complacent view toward our profession will do little to better it. Rather we must realize that improvement is in order, and that engineers individually and collectively as members of the Society should take steps to effect it.

*Swarthmore, Pa.* ROBERT W. RICHARDS, Jun. Am. Soc. C.E.
*Department of Civil Engineering*
*Swarthmore College*

## The Dewey Decimal System

TO THE EDITOR: In the July issue Ralph W. Spears has a commendable article, entitled "Needed—A Standard Filing System for Engineering Drawings." Probably almost every engineer has had the experience of wasting time and patience searching for some drawing upon taking over a position where the previous incumbent had a private system or none at all for filing drawings, tracings, and blueprints of various sizes. Engineers should be experts on systems and arrangements, but the writer's experience has been that, as a general rule, they are experts on messing up a filing system, especially when it has expanded far beyond its originally expected limit.

Mr. Spears' ideas of both a proper filing system and of the Dewey Decimal System are excellent, but I take exception to his suggestion for classification numbers. In the writing of by-laws of a newly organized society, Robert's Rules of Order for procedure are practically always specified. Certainly it would be foolish to attempt to write out rules for procedure when such an excellent one already exists. The same is true for a filing system. Why attempt to originate new numbers for a filing system when, as Mr. Spears says, "The 'Dewey Decimal System' has been tried and proved to be an efficient filing system. . . ."?

The Dewey System uses the whole numbers from 1 to 1,000 to include the entire field of knowledge, and everything can be filed under this system. Why, then, should Mr. Spears want to use whole numbers from 1,000 to 10,000 just for engineering when the possible number of decimals is only limited by infinity? He assigns all these whole numbers to only five fields of engineering, leaving out mining and including architecture, which is commonly included in the fine arts. The Dewey System already has numbers assigned "to the various engineering professions," as shown by the following tabulation:

| ENGINEERING | SPEARS PROPOSED NUMBERS | DEWEY NUMBERS |
|---|---|---|
| Agricultural | 1,000–1,999 | 631.6 |
| Architectural | 2,000–2,999 | 721 |
| Civil | 4,000–4,999 | 620 |
| Electrical | 6,000–6,999 | 621.3 |
| Mechanical | 8,000–8,999 | 621 |

Mr. Spears then assigns numbers to "the various types of projects within the respective engineering professions." In the Dewey classifications, there are numbers for all of these. There were no airdromes in the older editions, but the 1942 edition assigns the number 629.136 to this classification. Obviously drawings of all dams, for instance, should be filed near each other regardless of the engineering profession responsible for them. Since Mr. Spears proposes the decimal number of 250, this assigns various dams to the several professions.

By way of illustration, Mr. Spears picked a poor example as he assigns the decimal 0.4 to plans and the decimal 0.5 to profiles and then uses the number 4,500.45 as the filing number for a street plan and profile, which relegates profiles to the decimal 0.05.

The writer has used the Dewey System not only for filing maps and drawings, but also for filing trade catalogues and for numbering ledger pages for cost-accounting systems on construction jobs and has never found any need for numbers other than in the Dewey Decimal Classification extended but not "in modified form." His scrap book pages are also numbered with Dewey Decimal numbers. As an example in cost accounting on a construction job, take the item foundation. It is desirable to know the break-down of items for this, such as the cost for excavation, forms, reinforcement, concrete, and so on. By giving a ledger page for each one of these items a decimal number below that for the decimal for excavation which has a lower decimal number than that for, say "warehouse," to which the foundation belongs, the

numbered ledger pages will follow in order so that the complete detailed cost of the particular warehouse is all together. Should a ledger, with pages so numbered, be accidentally disarranged, the pages, if gathered up and arranged numerically, will show each building and structure with all its parts together. In addition, all corporation and personal accounts will automatically be arranged alphabetically.

C. TERRY DU RELL, M. Am. Soc. C.E.

*Redondo Beach, Calif.*

## Soil Mechanics in Building Design

TO THE EDITOR: As explained by Maj. G. E. Bertram in his article in the August issue, a knowledge of soil mechanics is important in the design of military airfields. What I wish to stress here is the fact that such knowledge is also important in the field of building design. And in this field particularly, its value is often underestimated.

Although the study of the mechanics of soils has long been of intense interest to many engineers, and lengthy reports have been written on investigations on this subject throughout the country, we are continually hearing of buildings becoming defective soon after they are constructed because of settlement in their foundations, floors, or other structural units.

In my work with various war agencies of the government and the Portland Cement Association during the past ten years, I have had the opportunity to investigate a number of large and small projects where the structural walls, partitions, and floors cracked and became defective because too much faith was placed in the supporting value of the soil. When will architects and engineers learn to give more thought to the mechanics of soils before they put up beautiful structures, with impressive architectural details, only to have them develop cracks and defects within a short time?

Some fifteen years ago, in the middle section of New York State, a large hospital building was designed by an outstanding authority on concrete and concrete design. However, before the general contractor was finished, the foundation walls showed a number of structural cracks caused by inadequate expansion joints and by failure to carry the foundation walls deep enough to reach a solid foundation.

Another example that came to my attention was a large mill building in the eastern part of Tennessee. This plant, designed by a firm of outstanding engineers, was placed on isolated footings. As the soil had very little supporting value, it was not long before the building began to settle. The reinforced concrete columns began to crack and belly out, and the company was forced to spend nearly a million dollars to pump grout around all the exterior walls. This condition could have been avoided had piles been driven and a concrete mat placed to equalize the load.

Another glaring example that came to my attention was a small multiple-story, flat-slab concrete garage near Niagara Falls. In his design the architect wanted to use an arbitrary figure of 6 tons per sq ft as the bearing value of the soil. His engineer suggested, as a result of preliminary studies, that this tonnage be reduced. However, the original figure was used, and the results might have been disastrous had not the engineer ordered construction joints placed approximately every 15 ft in the foundation walls. Soon after the building was finished, it settled approximately 3 in., as reflected in the front curtain brick walls. However, as the walls were not tied together, this settlement caused only light structural cracks in the columns and floor sections.

In conclusion it would appear that all the examples of faulty design mentioned, as well as many others, could be avoided if soil tests were made and a little money spent to make sure that the soil would withstand the loads, both live and dead, to be placed on it.

*Pittsburgh, Pa.* STEWART S. NEFF, M. Am. Soc. C.E.

[*Editor's Note:* Through an error that we regret, one line was omitted from Edward H. Sargent's letter to the editor in the August issue (page 380). The next to the last sentence of his discussion reads, "However, there are probably available many storage reservoir sites which are not economically sound for those combined purposes." It should read, "However, there are probably many available storage reservoir sites, which are not economically sound for those developments separately, but which are economically sound for those combined purposes."]

## Make Stream-Pollution Abatement Attractive to Industry

TO THE EDITOR: In his article, "A Rational Approach to Stream Pollution Studies," in the February issue, F. W. Kitrell presents the stream-pollution problem correctly, and his summary, "Sanitation Costs Money," is the crux of the problem. I should like to present an often-neglected avenue of approach to the problem of elimination of industrial wastes pollution.

Industries are responsible for much stream pollution, and the cost of abatement often weighs more heavily upon them than upon municipalities. When faced with the cost of wastes treatment, they ask the riparian communities, "Which is worth more to you, our weekly pay roll of so many dollars, or the esthetic value of a clean stream?" The payroll is obviously a potent argument. Reduce the cost of treatment of wastes, and you hasten the solution of the problem.

This may be done in two ways—by recovery of by-products of monetary value from the wastes, or by revamping processes of manufacture to reduce the amount of pollution discharged.

The sanitary engineer should never be content merely to obtain analyses and volume measurements of an industrial waste, and design a treatment plant from these data. He can serve his industrial client better by making, or having made, a thorough study of the various processes which contribute components of the waste discharged, and seeking to reduce or eliminate these components at the source. Tactful cooperation with the client's chemists or engineers is required, for often the client resents criticism of plant processes by someone not engaged for that specific purpose.

The feasibility of recovery of by-products from industrial wastes often may be determined better by research conducted by the industry concerned than by the average sanitary engineer, but the engineer should furnish the incentive for such research. There are innumerable industries which recover valuable by-products from their liquid and solid wastes, and it must not be assumed that the potentialities have been exhausted. It is certain that research will continue to find use for seemingly worthless components of industrial wastes. Recovery of by-products may not always show a profit, but it may reduce the cost of treatment to a tolerable figure.

In short, let us strive continually to better the argument for stream pollution abatement on the basis of reasonable costs—an argument more appealing to industry than esthetic values.

*Saipan, M.I.* GEORGE G. BOGREN, M. Am. Soc. C.E.
*Captain, Sanitary Corps, A.U.S.*

## Forum on Professional Relations

CONDUCTED COLUMN OF HYPOTHETICAL QUESTIONS WITH ANSWERS BY DR. MEAD

*In the current issue Dr. Mead gives his answer to Question No. 34, which was announced in the July number. The question reads as follows: "An undergraduate, who had attended the University of Wisconsin, in the chemical engineering department, for three years, worked one year in the chemical department of a medium-sized industrial concern. His work consisted in supervising a chemical process which was secret. The young man left and finished his university training. Near the end of his last year, a very attractive offer was made to him by a person who did not know these facts. The offer was for a position in a large industrial plant. Is the young man violating professional ethics if he accepts the position?"*

The writer does not believe any ethical principle is violated, provided the young engineer does not give to his new employer any secret information which he obtained in his previous position.

DANIEL W. MEAD, Past-President and
Hon. M. Am. Soc. C.E.

*Madison, Wis.*

Question No. 35, which was announced in the August number, will be answered in the forthcoming, or October, issue. Next in the series, the following question is announced. Replies may be received until October 5, with answers in the November number.

QUESTION NO. 36: *If an inspector on a job saved a contractor considerable money by showing him an easier method or short cut in doing some work, would the inspector be justified in receiving remuneration in money or otherwise from the contractor?*

# SOCIETY AFFAIRS

*Official and Semi-Official*

## An Engineers' Peace

ENGINEERS have accepted the fact that World War II has been an "Engineers' War." Even the public, through press and radio, has become conscious of the essentially important part engineers have played in this world-shaking conflict. Through the unselfish and unstinted efforts of engineers in all branches, in military service and in industry, this most horrible of all wars has been hastened to a successful conclusion.

It remains to be seen if engineers will take an equally important part in the processes of reconversion and the establishment of a peaceful world. It seems almost axiomatic that they should do so. The American Society of Civil Engineers, through its official acts, has shown that it is aware of the obvious fact that engineers must contribute as important a service in the winning of a world peace as they have contributed to the winning of the war.

Officers of the Society initiated the machinery, finally accepted by our government, for the making of expert surveys and reports on the industrial requirements for a Germany at peace. It is believed that the same pattern will be followed concerning Japan. The Society has sponsored an overall Committee on Opportunities for Veterans in the Construction Industry. Local Sections in the near future will be hearing more of the work of that committee and the manner in which they can help. At its July meeting in Detroit, the Board strongly endorsed universal military training. The Society took the lead among engineer organizations in attempting to convince the public of the necessity for early planning for post-war private and public works. These are but examples of Society effort toward helping to win the peace.

The Society itself is confronted with reconversion problems. About a fourth of our membership, some 5,000 men, have been or still are on military duty with the armed forces. Thousands more have put all their efforts into the development and production of war material. Quarterly conventions of the Society were not held during the war. Activities of the Technical Divisions have been curtailed materially. Censorship and security measures have handicapped our publications. The Society has been 100% "in the war," and there is no part of Society activity unaffected by the end of the war.

Never before in its long, rich history has the Society had so great an opportunity for public service. In rendering public service and in making the public conscious of that service, engineers will find the shortest distance to the goal of general betterment of their profession. Reconversion from war to a normal existence and a resumption of former Society activities should mean our reconversion into a stronger Society, an organization of civil engineers more than ever before dedicated to participation by engineers in questions of national importance. Society accomplishment, however, will continue to be but the algebraic sum of the accomplishments of its individual members in engineering and public activity.

The "Engineers' War" is over. The members of the American Society of Civil Engineers, together with all the other engineers in the Nation, must now demonstrate that their talents, so valuable in war, will be used toward the realization of an objective just as important—an "Engineers' Peace."

W. N. C.

## Mississippi River Inspection Supplements All-Day Meeting of Mid-South Section

THE mid-summer meeting of the Mid-South Section, held on August 3, was an all-day event. Section members were guests of the Mississippi River Commission aboard the Steamer *Mississippi* on an inspection trip of the river above Vicksburg. Extensive preparations had been made, and an unusually fine trip was the result.

Seventy members and guests made the all-day journey and inspected flood control works on the route of the 60-mile round trip. A symposium on "Flood Control on the Lower Mississippi River," as exemplified by the territory covered by the boat trip, was presented. Lt. Col. C. P. Lindner, president of the Section, presided. After outlining the program and the various features of the project to control and guide the Mississippi River for the greater usefulness of our country, Colonel Lindner introduced the speakers.

First on the program was Brig. Gen. Max C. Tyler, president of the Commission and division engineer of the Lower Mississippi Valley Division, whose subject was "Vicksburg Harbor and River Transportation." He reviewed the history of the Vicksburg Harbor—from General Grant's attempt to create a cut-off so as to by-pass the Confederate land batteries and Vicksburg's water-front and nature's success in accomplishing this cut-off in 1876, to the present-day harbor created by dredging and diverting the mouth of the Yazoo River. He also emphasized the magnificent job the Mississippi has done and is doing during the war emergency. During 1944 the river handled 13,000,000 tons of long-haul tonnage of which the greater part, or 11,000,000 tons, was upbound, the reverse of pre-war river transportation. River transportation has made possible the building of submarines, landing vessels, ocean-going tugs destroyer escorts, freighters, and tankers in inland yards where labor and materials were readily available.

SPEAKERS AND OTHERS POSE AT STEAMER RAIL
From Left, Messrs. Lever, Pickett, Tyler, Matthes, Smith, Williams, Lindner, Fry, and Shepard

Next on the program, Maj. A. B. Smith, chief of the Dredging and Navigation Branch of the Commission, spoke on "Channel Stabilization of the Mississippi River." He outlined the authorized $200,000,000 postwar project for river stabilization as passed by the Congress in House Document No. 509, February 1944, and pointed out that it is estimated prosecution of the program will take 15 years. Major Smith was followed by Gerard H. Matthes, director of the U.S. Waterways Experiment Station, who gave a talk on "Cut-Offs," reviewing the history and development of both natural and artificial cut-offs. Mr. Matthes described in detail the six cut-offs included in the day's trip and early attempts to prevent them. Of considerable interest was the background leading to the reversal of the established policy of preventing cutoffs and

the development of "cut-off technique" by Maj. Gen. H. B. Ferguson, formerly president of the Commission.

A talk on "Revetments" came next, with Lt. Col. A. B. Pickett, assistant to the District Engineer at New Orleans, outlining their development from willow mats through articulated concrete and asphalt mats to the latest rolled or "Pickett" type mat now under development. Some of the latter type of mattress was laid near Greenville, Miss., during 1944. Revetment work in the past required extensive and elaborate plant, and the work was consequently performed entirely by government plant and hired labor. The present policy is to develop a revetment that can be preformed by simple, inexpensive plant, so that contractors can do the work. This year's program calls for 190,000 squares of revetment in a five-month season, or the equivalent of the pavement required to construct a highway 200 miles long and 18 ft wide.

The head engineer of the Commission, Charles Senour, then spoke on the subject, "The Project for Flood Control on the Lower Mississippi." Mr. Senour reviewed the attempts at flood control from the days of De la Tour in 1717 to the present, covering the project for headwater as well as backwater control for the Mississippi and its tributaries in the lower valley. After the 1927 flood Congress authorized projects totaling 325 million dollars, which today have grown to 863 million dollars, of which 463 millions have been spent to date.

Near the End of Trip Members of Mid-South Section Wait as Steamer "Mississippi" Lowers Gangplank

The concluding paper, entitled "Plant and Equipment," was presented by J. C. Lever, chief of the Plant Branch of the Commission, who discussed the development of construction equipment used on the river for flood control and navigation, as well as inspection and survey plant. He pointed out that plant and equipment used on the lower Mississippi River total one-fourth of all items of plant in the War Department for civil work. This plant is valued at over $12,500,000.

Projects inspected during the day included Centennial, Yazoo, Willow, and Marshall cut-offs; Delta Point, False Point, Milliken, and Goodrich revetments; and the river channel between miles 342 and 460 above head of passes. During a short business meeting, also held on the steamer, the Postwar Planning Committee submitted a partial report. All in all, it was a notable day for the Mid-South Section.

## Sound Record of Bomber Crash

The usual skeleton staff was on duty at Society Headquarters on the morning of Saturday, July 28, for what proved to be the most exciting few hours that most of them had ever experienced. It was the occasion of the tragic crash of the B-25 Bomber into the Empire State Building. Society offices are on the top two floors of the Engineering Societies Building, so that most of the offices have a clear view of the Empire State Building about a thousand feet away.

All present on that fateful morning heard the roar of the low-flying bomber, and several actually saw its impact on the Empire State Building. During the ensuing Army Board Investigation a number were interviewed in an effort to determine facts as to the course of the plane.

One feature of special interest was a sound recording of the plane as it passed the Headquarters building about 3 seconds before it struck. At the time Assistant Secretary Jagger was using a radio type-recording dictator. As the plane passed only a few hundred feet away the roar of the motors drowned out his dictation and was faithfully recorded. After the excitement had passed, the fact of the recording was discovered and Mr. Jagger immediately notified Air Corps authorities.

Later, the Army Board of Investigation called at the office, evidenced great interest in the recording, and had copies made for Army record. According to these authorities, it indicated that the engines of the plane were functioning in an entirely normal manner.

## Cooperation in Postwar Planning

Another forward step to boost the preparation of plans for postwar construction was taken at a joint meeting held at Society Headquarters on July 20, and called by the Action and Advisory Committee on Construction of the Committee for Economic Development (CED). It invited representatives from the American Institute of Architects, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Chemical Engineers to join with the Society in this meeting.

The societies responded by appointing the following members from their organizations: Arthur C. Holden, A.I.A.; E. A. Prentis, A.I.M.E.; Robert S. Hackett, A.S.M.E.; Gano Dunn, A.I.E.E.; and C. R. Downs, A.I.C.E. Messrs. Prentis and Dunn are also members of the Society. In the general discussion at this meeting the problems facing the construction industry in the postwar period were analyzed and methods for meeting these problems were sought. It was agreed that if the construction industry, as one segment of our economy, is to carry its share of the postwar high-level employment, a 15-billion-dollar annual construction program must be maintained.

On the basis of records from the last quarter of a century, such a program would normally involve about 5 billion dollars of public works and 10 billion dollars of privately financed construction, divided roughly 50% for private housing and 50% for private commercial and industrial projects. To meet this goal without a transition period of unemployment, plans must be prepared now to carry on this amount of construction.

Except for possible delays in local and federal financing of public works and in legal hurdles still to be overcome, the goal of a 5-billion-dollar public works program for the first postwar year seems likely to be reached.

Information as to the amount of public works which might be in a "ready-for-bids" stage by an estimated V-J Day is much more reliable than similar information regarding private construction work. With V-J Day then estimated as December 31, 1945, available information indicated the likelihood of realization of the public works goal of 5 billion dollars worth of work "ready for bids" on that date. Because of natural difficulties in obtaining data from private industry on its postwar construction plans, there are differences in expert opinion on the amount of privately financed construction now in the design or completed plan stage. It appears more than doubtful if, without some outside stimulus, a 10-billion-dollar privately financed program of construction can be ready at V-J Day. A part of the stimulus required can be given by the engineers, architects, contractors, and others interested in the construction industry in their respective communities.

Since about twice as much time is required to bring a project to the blueprint stage as is required to construct it, no delay should be countenanced in the immediate preparation of plans to achieve the 10-billion-dollar privately financed construction quota for the first postwar year.

To implement this program, the representatives of the various organizations agreed to recommend to their respective national organizations the immediate appointment of construction committees in each of their local chapters to work with the local CED committee in each of their respective communities. The CED is a voluntary association of business men with all of its officers and all of its finances from private business.

Two years ago the Society formed a Committee on Postwar Construction and launched a campaign to have plans prepared ready for bids for a 15-billion-dollar program of construction at the end of the year. This Committee, with G. Donald Kennedy, M.

Am. Soc. C.E., as chairman, worked the first year establishing policies and laying the groundwork.

Later the Society Committee joined in the CED effort and became an Action and Advisory Committee to CED. During the past year the Committee's work has been carried on by a Society staff working closely with the CED. During the year, all 61 Local Sections of the Society within the continental United States have appointed local committees on postwar construction to work with CED local organizations, of which there are nearly 3,000.

Union of the various societies at the national level has been completed in the Action and Advisory Committee on Construction of the Committee for Economic Development. This union is only the beginning of the process. The combining of the various Local Section committees at community level has yet to be completed. The latter action already has been delayed too long. The national committee urges members of the professional societies not to wait for further word from national headquarters, but to volunteer their services to their local CED chairmen for any technical advice or action which will assist in the accomplishing of our common goal—enough completed construction plans ready for bids in every community to utilize all available local construction labor at a high-level of employment. It is only in this manner that each community can control to its own advantage the part that immediate postwar construction will play in preventing at local level a serious unemployment situation.

## Honorary Member Edwin A. Fisher Feted on His 98th Birthday

FEW attain the age of ninety-eight, and of those who do, fewer still continue active in their work. Among these notable exceptions is Edwin A. Fisher, Hon. M. Am. Soc. C.E., of Rochester, N.Y., who was entertained at a luncheon on July 17 in honor of his 98th birthday.

Lauded "as a man whose aim for more than sixty years has been the betterment of Rochester," Mr. Fisher served as city engineer from 1895 to 1914 and has been consulting engineer for the city since the latter date. Though he officially "retired" in 1926, he still visits his office daily, putting in five or six hours on problems of water supply, flood protection, and city planning. While he was

HONORARY MEMBERS CONFER

Recently H. S. Crocker (Right) of Denver, Was Entertained by Edwin A. Fisher in Rochester, N.Y. Despite His 98 Years, Mr. Fisher Goes to His Office Daily

city engineer Mr. Fisher originated numerous local projects—among them the Cobbs Hill Reservoir, the sewage-treatment plant at Durand-Eastman Park, and the location of the Barge Canal through Genesee Valley Park. In more recent years he has published a book on flood protection for the Genesee River.

At the luncheon over fifty friends, City Hall workers, and engineers helped him celebrate, and he was cited as "the most titled engineer in Rochester." In addition to his honorary membership in the Society, to which he was elected in 1929, Mr. Fisher is also an honorary member of the American Society of Planning Officials and president emeritus of the Rochester Engineering Society and the American Public Works Association.

The accompanying photograph shows him with another distinguished Society member—Herbert S. Crocker, Past-President and Honorary Member. Colonel Crocker, who is an authority on water supply and tunnel construction projects, visited Mr. Fisher recently en route from Cape Cod to his home in Denver.

## Tellers Report on First Ballot for Official Nominees

*To the Secretary* *August 1, 1945*
*American Society of Civil Engineers*

The tellers appointed to canvass the First Ballot for Official Nominees report as follows:

*For Vice-President, Zone I*

| | |
|---|---|
| Arthur W. Harrington | 208 |
| Ole Singstad | 192 |
| Scattering | 75 |
| Ineligible candidates | 81 |
| Void | 0 |
| Blank | 5 |
| Total | 561 |

*For Vice-President, Zone IV*

| | |
|---|---|
| J. T. L. McNew | 360 |
| Fred C. Scobey | 57 |
| Scattering | 140 |
| Ineligible candidates | 131 |
| Void | 0 |
| Blank | 15 |
| Total | 703 |

*For Director, District 1*
(Two to be elected)

| | |
|---|---|
| Shortridge Hardesty | 194 |
| Irving V. A. Huie | 188 |
| Scattering | 76 |
| Ineligible candidates | 87 |
| Void | 0 |
| Blank | 23 |
| Total | 568 |
| (One half of above figure) | 284 |

*For Director, District 2*

| | |
|---|---|
| Albert Haertlein | 134 |
| Scattering | 13 |
| Ineligible candidates | 17 |
| Void | 1 |
| Blank | 0 |
| Total | 165 |

*For Director, District 6*

| | |
|---|---|
| Wm. R. Glidden | 132 |
| Scattering | 15 |
| Ineligible candidates | 20 |
| Void | 0 |
| Blank | 0 |
| Total | 167 |

*For Director, District 10*

| | |
|---|---|
| Wm. M. Piatt | 50 |
| Edwin Day Burchard | 41 |
| Robert M. Angas | 13 |
| Fred J. Lewis | 12 |
| Scattering | 46 |
| Ineligible candidates | 33 |
| Void | 0 |
| Blank | 0 |
| Total | 195 |

*For Director, District 13*

| | |
|---|---|
| F. W. Panhorst | 110 |
| H. H. Hall | 81 |
| Scattering | 19 |
| Ineligible candidates | 34 |
| Void | 0 |
| Blank | 1 |
| Total | 245 |

| | | |
|---|---|---|
| Ballots canvassed | | 2,320 |
| Ballots withheld from canvass: | | |
| From members in arrears of dues | 34 | |
| Without signature | 3 | 37 |
| Total number of ballots received | | 2,357 |

*Respectfully submitted,*

David G. Baillie, Jr., *Chairman*
George L. Freeman, *Vice-Chairman*

| | | |
|---|---|---|
| Frederick W. Ockert | James D. Parsons | Harry Newman |
| Joseph Farhi | Ernest H. Harder | G. C. Maguire |
| Arthur D. Fields | J. H. Granbery | Theodore P. Kilian |
| Emanuel L. Pavlo | Milton G. Salzman | Jacob Mechanic |

*Tellers*

## The Engineer in Foreign Service

### *West Sees East*

*By* Llewellyn Evans, M. Am. Soc. C.E.

I'm in a strange part of China and have witnessed some of the most unusual engineering feats, so I must sacrifice some sleep to write a short record and send it to you.

I have just seen a drilling rig in a salt well which was down 3,000 ft, with bamboo drill cables—just plain 2-in. straps of bamboo split from the shell of large bamboo poles and laced end on end by lapping and binding with linen thread. The drill makes a few feet each day, sometimes as little as 2 ft. There are some hundred and forty 1,000-ft wells, forty 2,000-ft wells, and ten or more 3,000-ft wells drilled this way. They are cased with wood shells to bedrock and then uncased except through leaks, where special operations are needed to seal them. They are using tung oil and lime as a cement. It sets up like cast iron, a truly wonderful cement.

The wells that are operating are connected with common evaporating centers by bamboo pipe lines—thereare milesof thesepipes—up to 200-lb per sq in. pressure. The 4-in. bamboo rod is cleared of section walls and wrapped continuously with rattan serving; these servings are pulled tight with wood wedges. The joint between sections is just a hand-fitted socket or bell-and-spigot joint sealed again with tung oil and lime cement.

#### Bailing Operation

The bailing operation of extracting the brine from the well is still done by the buffalo winch on many wells, but a few have simple steam winches and steel cables; the exhaust goes to an evaporator.

All the wells produce some natural gas; the pressure is controlled by the height of the water plug kept on the gas. When more gas is needed, a few bailfuls are pulled out, as that way the gas will keep the evaporation fires going.

Almost every well is owned by a different man and there are as many schemes of drilling, bailing, and evaporating as there are men. The by-products are numerous—iodine, bromine, sodium bicarbonate, borax, calcium chloride.

#### Reminders of TVA

The salt trade has built a canal system to get down to the big river—several locks and dams. I saw a 6-meter lock lift this afternoon. There are a few features that are new to me—the lock is twice the width of the gate so that two rows of barges (junks) can be admitted at once. The traffic requires almost continuous operation.

The work is all in stone masonry, by an engineer who never was in the States. The miter gates are of wood timbers with iron bindings, built just like $^1/_2$ of TVA gates, but hand operated with a rack and gear and sweeps and two coolies. They allow fishing with nets right in front of the dam. They get lots of fish and a small shrimp—grand eating. The fisherman stands up in his boat and splashes the water to scare the fish into his net.

Our jeep was surrounded with people when we got back to the village street—paved a foot thick with stone slabs and 40 ft wide, polished with the sandals of thousands for thousands of years. Many had never seen an auto of any kind. All through China the kids put thumbs up and cheer when you travel on the main highways. The G.I.'s have them trained, but in this out-of-the-way spot they didn't know what to do except to look frankly at us and smile—plenty friendly.

Stone is the universal building material. I saw a 30-ft structure for a 33-kv gang-operated switch made of three 24-in. piers that would carry a railroad bridge—cut stone with a neat inscription on the outside structure. And I could keep on for the rest of the night but the day starts at daylight tomorrow.

I am finding these Chinese engineers well versed in TVA objectives and that they have some knowledge of the TVA work through digests. No technical magazines have come there since 1941. They say they are all piled up and preserved in India to come through later to fill the files of the libraries and technical schools.

(*From a letter to C. E. Blee, M. Am. Soc. C.E., reprinted from the July 1945 "Tennessee Valley Engineer," publication of the Society's Tennessee Valley Section.*)

## Sponsorship for Study on Controls Over Construction Industry

In the interest of accuracy, a correction should be noted in the editorial note at the head of the article, "Relaxation of Controls on Construction Recommended," on page 384 of the August number.

Credit for the report on recommendations should go to a committee of the Construction and Civic Development Department of the U.S. Chamber of Commerce and not to the War Production Board. The Construction Industry Advisory Group is sponsored by the Construction and Civil Development Department.

# News of Local Sections

## Scheduled Meetings

Colorado Section—Dinner meeting at the Oxford Hotel on September 10, at 6:30 p.m.

Connecticut Section—Dinner meeting at the Hartford City Club on September 26, at 6:30 p.m. Subject, "Postwar Plans of Connecticut Industry," by Norris W. Ford, exec. vice-pres., Manufacturers Association of Connecticut.

Dayton Section—Luncheon meeting at the Engineers' Club on September 17, at 12:15 p.m.

Los Angeles Section—Dinner meeting at the University Club on September 12, at 6:45 p.m.

Louisiana Section—Smoker at the St. Charles Hotel on September 24, at 8 p.m. Subject, "Military Construction in Alaska," by Col. Fisher S. Blinn.

Maryland Section—Dinner meeting at the Engineers' Club on September 20, at 6 p.m.

New Mexico Section—Meeting at Santa Fe, N. Mex., on September 19, at 8 p.m.

Oklahoma Section—Luncheon meeting at the Chamber of Commerce Building on September 8, at 7:30 p.m.

Sacramento Section—Regular luncheon meetings at the Elks Club every Tuesday at 12 m.

San Diego Section—Dinner meeting at the U.S. Grant Hotel on September 27, at 6:30 p.m.

Tennessee Valley Section—Dinner meeting of the Chattanooga Sub-Section with the other Founder Societies at the New China Restaurant on September 11, at 6 p.m.; dinner meeting of the Knoxville Sub-Section at the S & W Cafeteria on September 12, at 5:45 p.m. There will be pictures and discussion of Fontana Spillway Design and Tests, with George Hickox in charge of the program.

Texas Section—Luncheon meeting of the Dallas Branch at the Adolphus Hotel on October 1, at 12:15 p.m.

Tri-City Section—Smoker at the Blackhawk Hotel on September 14, at 8 p.m.

# Recent Activities

### Alabama Section

The May meeting of the Alabama Section, which was held in Mobile, attracted an attendance of about fifty. The list of speakers included W. C. Ernest, Jr., major, Corps of Engineers, U.S. Army, and E. M. Stickney, superintendent of the Mobile Water Works. Major Ernest, who had just returned from the South Pacific, spoke most interestingly of his experiences, while Mr. Stickney gave a talk of a philosophical nature. Assistant Secretary James E. Jagger was one of the Section's guests for the occasion.

### Iowa Section

A joint dinner meeting of the Iowa Section and the Student Chapter at Iowa State College took place at Ames on July 23. Guest of honor and principal speaker was John C. Stevens, President of the Society whose subject was "Know Your Society." An enthusiastic open forum concluded the program.

### Kentucky Section

On May 11 the Kentucky Section was host to the Student Chapters at the University of Kentucky and the University of Louisville. When dinner was over, the meeting was turned over to C. C. McDonald, of the University of Louisville Chapter, who introduced six speakers competing in the Section's prize contest for student papers. The contest resulted in the award of a first prize of $15 to Gilbert Weddington, of the University of Louisville, for his paper on "Louisville's Ground-Water Problem"; a second prize of $10 to Miss Anne Phillips, of the University of Kentucky, for a paper on the "Kennedy Mill Bridge"; and a third prize of $5 to Donald Bornstein, of the University of Louisville, for his paper on "Postwar Residential Building." During the evening it was announced that the Section's annual awards of Junior membership in the Society go to Duane Van Horn, of the University of Kentucky, and Charles R. Pullin, of the University of Louisville.

### Northwestern Section

A special dinner meeting of the Section was arranged on July 24 to honor President J. C. Stevens and Col. W. N. Carey, Secretary of the Society. Colonel Carey described the personnel and organizational set-up at Society Headquarters, while Mr. Stevens discussed the activities of the Society, stressing its cooperation with other engineering groups in doing something for the public in general and for junior engineers in particular.

### Panama Section

On July 18 members of the Panama Section enjoyed another interesting inspection trip—this time to Floating Drydock YFD 6 in Balboa inner harbor. The drydock had recently been towed through the canal, and members had an opportunity to view it in operation. The trip was made under the auspices of Capt. H. S. Jeans, of the U.S. Navy, who is industrial manager of the 15th Naval District at Balboa.

### Puerto Rico Section

The Puerto Rico Section reports that its third technical meeting of the year consisted of an inspection trip and luncheon on July 14. Members of the Section and a number of guests visited a newly constructed glass factory that will produce 100 tons of glass a day and a large paper mill under construction. At both plants explanatory talks were given by staff members of the Puerto Rico Development Company, and later the group was entertained by the company at a luncheon.

### Sacramento Section

The Sacramento Section meetings of July 3 and 31 consisted of progress reports by the Committee on the Western Pacific Problem, which was appointed by the Section in October 1944 to study alternative plans for relocating or regrading the Western Pacific Railroad's main-line tracks through Sacramento. The latter session was held in the evening, in lieu of the weekly luncheon meeting, in order to allow more time for the progress report and for general discussion from the floor. A film entitled "Winning the Battle of Synthetic Rubber" was presented at the luncheon meeting on July 10.

### San Diego Section

"The Future of San Diego" was discussed by Elwood Bailey at the May 24 meeting of the Section. H. L. Thackwell, Field Secretary of the Society, then spoke on the present status of collective bargaining as far as the Society is concerned, and explained the current court case of the Southern California Gas Company vs. the C.I.O. At the June 14 meeting of the Section President Stevens discussed the state of helpful cooperation existing among the various engineering societies.

### Spokane Section

Much of the May meeting of the Section was devoted to discussion of postwar planning and to efforts to counteract the alleged laxity of local groups in this field. There was additional discussion of the subject at the June 15 dinner meeting. The technical program for the latter occasion consisted of a talk by S. B. Murray, soil conservationist for the U.S. Indian Service, whose topic was "Soil Conservation and the Utilization of Water."

### Tacoma Section

An inspection trip through the Todd-Pacific Shipyards in Tacoma had been arranged for the regular June meeting of the Section. Members and guests assembled at the plant's cafeteria, where dinner was served to the group. Then George F. Kachlein, general manager of the Tacoma yards, gave a brief outline of the work being done at the shipyards and described its expansion in the years since 1939, when it was constructed. Approximately two and a half hours were then spent in touring the yards under the guidance of Mr. Goodrich, chief engineer, and ten members of his staff.

# Student Chapter Notes

### Lehigh University

The Lehigh University Student Chapter announces that it is again functioning after a period of inactivity due to the war. The reactivated Chapter, which has 23 members, held its first meeting on April 19. On this occasion the speaker was L. D. Matter, district engineer for the Pennsylvania State Department of Health, who outlined the state organization and spoke on stream conservation. Inspection of the materials testing and hydraulics laboratories in operation concluded the meeting. On May 14, members of the Chapter were guests of the Lehigh Valley Section at a dinner meeting, which was addressed by E. Leland Durkee, of the Bethlehem Steel Company. Mr. Durkee described the construction of the Pecos River bridge in southwestern Texas. On May 22, there was a get-together dinner with the faculty, at which roast beef was the pièce de résistance! And on July 12, H. O. Hill addressed the group on welding, especially in connection with ship construction. Mr. Hill is assistant chief engineer for the Bethlehem Steel Company.

E. L. Durkee Discussing Construction of Pecos River Bridge with Pete Facchiano, Treasurer of the Lehigh University Chapter

# ITEMS OF INTEREST

*About Engineers and Engineering*

## An Unsolved Problem

*By* J. Charles Rathbun, M. Am. Soc. C.E.
Professor of Civil Engineering, College of the City of New York

To engineers, the contemplation of ancient ruins is usually as dry as the ruins themselves. But at Baalbek the contrary has proved true to more than one of the members of the Society when on a tour of the Near East.

Actually the construction problems that arise in one's mind, as one views these old

A Medium-Sized Stone at Baalbeck
Note Person in Front for Scale

temples, are quite intriguing; for here the builders decided, for reasons best known to themselves, to use stones of gigantic size. The stones were quarried, moved some distance to the site, and placed in correct position, fitting tightly on side, bottom, and ends. Some of these stones weigh between eleven and twelve hundred tons. One of them, the largest, measures some 70 ft long, while its cross section is between 17 ft 8 in. by 13 ft 10 in. (as measured by one authority) and 13 by 14 ft (as measured by another). Even the latter measurement makes it still a big stone.

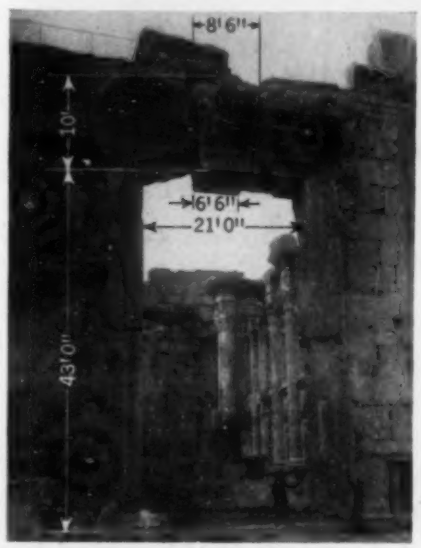
While visiting the site another American tourist, who spotted the writer's Society pin, asked how this engineering feat had been accomplished. He was told that it was quite simple for an engineer, but the method was too hard to explain in non-technical language.

### Manpower the Prime Mover

In the days of temple building, machinery was either non-existent or crude. Manpower was the prime mover. It is interesting to speculate as to how many men were required to place such a stone and where they stood when they moved it. Even Galileo couldn't solve that sort of problem when he tried his lever against the world. Not only did these ancients move the stone, but they slid it into place where it fitted perfectly on four faces. How did they do it? In comparison, the building of the Great Wall of China and the Pyramids was simple, if enough labor was available.

The principle of the sand pile, whereby a building is buried in sand as the work progresses, thus allowing the stones to be dragged or lowered into position, has been suggested as a method of construction for some of the works of Upper Egypt. At Baalbek (the name the Mohammedans gave to ancient Heliopolis) this method would have presented difficulties. Not only were the weights much greater, but also it would have been an unsolvable problem to get the sand from under one of these large stones so that it could rest flat on the others. Of course these stones could have been slid into place if enough force were used, but did they have hydraulic jacks in Julius Caesar's day? Shallow holes in the stones indicate that they may have been lifted by grappling hooks—the sky hooks of a Syrian Paul Bunyan perhaps. It has been suggested that cakes of ice were used to support the stones until the sand could be removed. Maybe so—but there was no ice in Baalbek the day the writer was there, and no prospect of getting any.

In short, the writer believes these are the largest stones ever placed in any construction, and he is much puzzled as to how they were handled, or in fact how they would be handled today.




The Main Doorway, Temple of Bacchus, with Vista of Interior

The temples at this location are not only massive but they are beautifully carved, even to the ceilings. The amount and size of the stone carvings indicate that labor, both skilled and unskilled, was plentiful and cheap. The Greek influence is seen in much of this work.

All that remains of the largest building is a row of nine columns surmounted by their entablature. These columns have shafts about 60 ft high with a diameter at the base of 7 ft and at the top of $6^1/_2$ ft. The shafts are in three sections, showing that even for these builders there was a limit to the size of the stones that could be handled. Probably the difficulty was in setting them upright. The sections are doweled together with iron pins over 12 in. in diameter and a foot long.

The other large temple, called the Temple of Bacchus, is in a far better state of preservation. It has a ground plan of 124 by 225 ft. There were 8 columns across the ends and 15 along the side. Accompanying photographs of this structure give an idea of the magnitude of this group of buildings when new. No cement

The Circular Temple, or Temple of Venus

was used in any of the structures, the stones being carefully fitted and held in position by gravity alone.

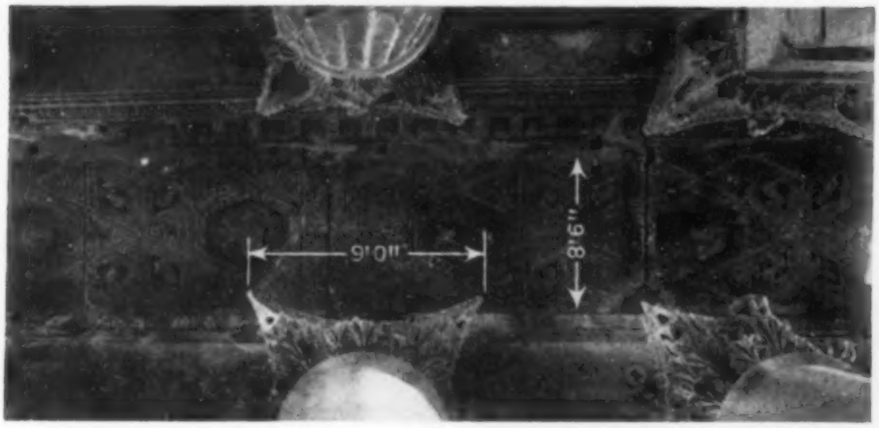
A very interesting but comparatively small circular temple stands apart from the rest. It was, for some time, used as a Greek church. Although its present state of preservation is not good, enough remains to deserve more than passing interest.

### Built for Worship of the Sun

That the sun has taken a special interest in Baalbek cannot be denied by anyone who has visited it in the summer time. The barrenness of the hills (accentuated by the snow which is visible on the distant mountains) testifies to the fact that this friendliness is a little overdone. But why the people should have felt it fitting to express a return affection by building temples for its worship is another unsolved problem. The stars there seem much more kindly, and an observatory would have been much more useful. But the idiosyncrasies of the Syrian (or was it Roman) mentality should not be subject to conjecture by wandering engineers.

Historically little is known about the structures at Heliopolis (Greek for City of the Sun). Of course we have the well-authenticated story that it was built as a pleasure resort, in season, for the Queen of Sheba; also that it was built with the aid of supernatural powers. These stories are interesting but probably not entirely accurate. In the first place, Solomon was a wise man and would have used smaller stones; in the second place, no spirits known to modern theology, or gods known to mythology could, or would, lift and place eleven hundred tons of stone in one piece; and in the third place, the buildings were not there when Alexander overran Syria.

RUINS OF THE TEMPLE OF BACCHUS ARE FAIRLY WELL PRESERVED
This Building Is 124 Ft Wide




CARVINGS ON CEILING, TEMPLE OF BACCHUS, LOOKING STRAIGHT UPWARDS

We do know that the Egyptian as well as the Greek influence was strong in the design and construction of these temples. When the Christians came, they broke and destroyed many statues and defaced many of the ornaments. Theodosius, Emperor of Rome in the fourth century, destroyed the Great Temple and used the material to convert the rest of the group into a place for the worship of Christianity. And some columns used in the construction of St. Sophia at Istanbul about 540 A.D. were taken from Baalbek. Much destruction was wrought by the Bashas of Damascus in order to obtain the iron dowels used in the columns. In the thirteenth century the Turks used material from these buildings to erect a mosque. But the Crusaders were never able to take the place.

One of the greatest wonders about the ruins at Baalbek is that no reports or records seem to be available describing how this wonderful construction feat was accomplished. The people were, seemingly, further advanced in engineering than in literary skill.

As I looked at those great temples built for the worship of the sun, now in ruins because of time and the avarice of man, I thought of the last verse of an old schoolday poem:

> And the widows of Ashur are loud
> in their wail,
> And the idols are broken in the
> Temple of Baal;
> And the might of the Gentile, unsmote by the sword,
> Hath melted like snow in the glance
> of the Lord.

## Abbreviated Annual Meeting of American Welding Society

IN harmony with the spirit of the times the American Welding Society is not attempting to hold its regular annual meeting during the current year. Instead, its national officers, board of directors and committee chairmen will meet at the Hotel Pennsylvania, in New York, on October 18. In addition to official board action, there will be the usual presentation of prizes, medals and awards. Papers that would normally be presented at the annual meeting are to appear in the society's *Welding Journal.*

Membership in the American Welding Society now totals over 8,500.

## Demountable Homes House Bomb Workers

As the phenomenal news relative to the development of the atomic bomb filters through official channels, it is being discovered that many individuals, organizations, methods, and materials were involved. It is known that cities sprang up in Tennessee and Washington, with gigantic housing projects to accommodate the workers and their families.

One method was adopted from the experience of the TVA with ready-built housing units. According to the Douglas Fir Plywood Association, this proved particularly useful in the rapid and efficient care of large influxes of population.

In all, 6,300 prefabricated plywood houses were used. These were manufactured in dimensions 8 by 8 ft in cross section and up to 24 ft long—that is, of a size that could be transported over highways. Much of the furniture was built in, and a considerable proportion of the plumbing and light fixtures was already installed. As a result only 5 to 10% of the total work of erection had to be done in the field. This included the foundation and the placing of the units. In all 35 million ft of plywood was used for interior and exterior walls, roofs, and floors.

Details of this method of housing were given in the July 1941 issue of CIVIL ENGINEERING, in an article covering the experiences of the TVA in developing and modifying this idea for practical use. The success in the earlier case is attested by the adoption of the same idea for a much wider application in the cities built for the atomic bomb plants.

## Highway Engineers from China to Study in U.S.

TWENTY-SIX Chinese engineers who expect to have an active part in the future development of China's highways will spend several months working in various state highway departments, gaining practical experience in highway and bridge design, construction, maintenance, equipment, and material-testing methods used by highway engineers in this country.

They are part of a group of over 700 Chinese who arrived in the United States recently to devote a year to the study of communications, engineering, industrial, and agricultural problems. They were brought to this country under the auspices of the Foreign Economic Administration, with the cooperation of the International Training Administration, Inc., and the Chinese Supply Commission. While in the United States they will receive subsistence pay under lend-lease provisions.

An additional group of 500 or more Chinese trainees are expected to arrive in the near future, making this the largest international training program of its kind in world history. After a short orientation course at Georgetown University in Washington, the trainees are assigned to federal and state agencies and private industrial organizations for actual work in their particular fields of study.

The 26 Chinese studying highway matters are college or university graduates who have degrees in civil engineering. Four members of the group have been assigned to the state highway department in California, five to Washington, three to Oregon, two to Wyoming, two to Texas, one to Ohio, four to Pennsylvania, two to Maryland, one to North Carolina, one to South Carolina, and one to the materials-testing laboratory of the Public Roads Administration of the Federal Works Agency in Washington, D.C.

Later in the year they will be transferred to other states in order to give them experience in several types of road construction and design in different sections of the country. Arrangements for the Chinese engineers to work with state highway departments were made by the Public Roads Administration at the request of the International Training Administration.

## Report on Wartime Technological Developments

A 400-PAGE report on "Wartime Technological Developments" has been compiled by the Senate Subcommittee on War Mobilization and prepared by the U.S. Bureau of Labor Statistics. This study is limited to published information, and does not include important wartime developments, which must remain secret at the time for reasons of national security. It constitutes, however, the first attempt to compile and digest information already released on hundreds of scientific achievements, and is a useful survey for persons and agencies engaged in formulating postwar programs.

Copies may be obtained through the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. The price is 50 cents each.

## A Manual for Surveyors Issued

A BULLETIN, entitled *The State Coordinate Systems* ("A Manual for Surveyors"), has just been issued by the U.S. Coast and Geodetic Survey as Special Publication No. 235. The authors are Hugh C. Mitchell and Lansing G. Simmons.

The manual is designed to aid the surveyor who intends to use a state coordinate system for referencing a land or engineering survey so that its results can be placed on a lasting basis and coordinated with surveys in other areas. In accomplishing this, only plane surveying methods and formulas are employed. The state coordinate systems are described, and procedures which their use involves are explained and exemplified by carrying through the computation of a farm survey. The several appendixes contain essential information relating to the state systems themselves, a report on their adoption by legislative enactment, and some formulas and tables that will aid in placing a land survey on a state system.

The manual is for sale by the Superintendent of Documents, Washington 25, D.C., at a cost of 25 cents.

## N. G. Neare's Column

*Conducted by*

R. ROBINSON ROWE, M. AM. SOC. C.E.

THE Professor hesitated, hating to interrupt a heated discussion of the persuasive impact of atomic bombs on world peace. Opinion of the Engineers' Club was divided on Yank propensities for bragging and lend-leasing. With modest extroversion he turned the subject to the impact of bulls on toreadors and called on Guest Professor Jenney to conclude his problem of the last daze of Don Pedro Fugatoro.

"We were to find how far he ran before Adam, get of Ferdinand, intercepted him 10 ft shy of safety," recalled Jenney. "This mathematical bull upset the odds by running true instead of in pursuit. I'm listening for answers."

"There are two," replied Joe Kerr, "so I suppose you want the smaller—60 ft."

"I'd say the larger and prove it with this sketch," argued Cal Klater. "The general

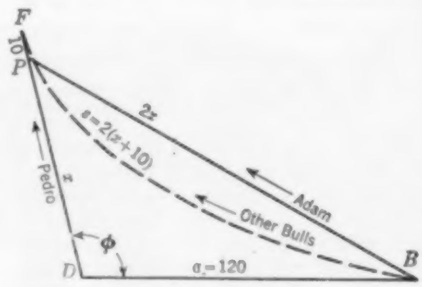



FIG. 1. ADAM GETS HIS MAN

expression for the length of the pursuit curve is

$$s = \frac{a}{1 - k^2}(1 - k \cos \phi) \times$$

where $k < 1$ is the speed ratio. From the given data,

$$2(x + 10) = \frac{120\ (1 - {}^1/_2 \cos \phi)}{1 - {}^1/_4}$$

whence $\cos \phi = (70 - x)/40$.

"If Don Pedro at $D$ faced the bull at $B$ and glanced over his left shoulder at the flagpole $F$, then $\phi > 90°$ and $x > 70$ ft. Next, $\Delta$ BDP and the law of cosines gives,

$$\cos \phi = \frac{x^2 + 120^2 - 4x^2}{240x} = \frac{70 - x}{40}$$

which reduces to $(x-60)\ (x-80) = 0$. So $x = 80$ ft."

"Simple, direct, and right," applauded Professor Jenney. In fact, Noah, all I can add is that Cal's first equation makes the problem look easier than it is. The derivation is a nice exercise."

"Thanks, Dick. Perhaps some of the Club will prefer that to our new problem of a postwar survey party in Wales. Chief of Party Tom Liwyendys had bought an over-age jeep that could run at 15 mph. One morning he had a rush call to Gnireenignelivic 47.5 miles away that proved difficult to keep.

"Transit, chain, level, rod, maps, and hubs filled the rear seat, leaving room for him and one passenger up front. His two chainmen could walk 5 and 4 mph, respectively, but the transitman was held to 3 mph by a service-connected limp. How long did it take the party to get to Gnireenignelivic?"

[*Cal Klaters were G. H. Wilsey, Benjamin A. Wasil and John L. Nagle, two of whom used oblique Cartesian coordinates to derive Cal's first equation. Gnireenignelivic is pronounced "Gnilc."*]

## Transport Maps Issued by Public Roads Administration

A REVISED edition of the California transportation map, consisting of 21 sheets, has been prepared by the Public Roads Administration of the Federal Works Agency for general distribution. The map, drawn to a scale of four miles to the inch, shows in color the location and character of all state and federal-aid highways, important secondary road connections, airports, canals, navigable streams, and other transportation facilities in California. Boundaries of national and state forests and parks, Indian reservations, wild-life refuges and recreational areas, and roads leading to them, also are shown. The highway information was prepared by the cartographic section of the P.R.A. and superimposed upon base maps compiled by the U.S. Geological Survey.

The California map is one of a series of state transportation maps which the Public Roads Administration has issued at intervals since 1936. Maps have been published for 26 states. Maps for 11 other states are in process of compilation or awaiting final printing. They are printed on sheets of uniform size, 26 by 36 in., and are too large to be used conveniently for touring. They are designed primarily for use by the War Department and other government agencies, and by state and county highway engineers and planning agencies.

Copies of the California map may be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. The price for the complete set of 21 sheets is $5.50. A limited supply is reserved by the Public Roads Administration for distribution to qualified educational institutions, public libraries, and state and county officials.

## Arc Welding for Aluminum Floating Bridge

PROCEDURES are now released covering the methods and manufacture of the Army's light-weight pontoon bridge, built of aluminum. Structurally this bridge consists of a series of balks or hollow square beams built of aluminum alloy, placed by hand, and capable of supporting 50 tons. These lock together with pins and form a flooring that rests on pontoons.

Recent developments involve a new method of welding the box section of the balk by joining together two channels.

The method is described as the atomic-hydrogen arc-welded process, using an inert arc alternating current process without flux. This method was developed by the General Electric Company, which claims for it economy in both speed and cost over previous methods. The elimination of flux is one of the added advantages.

## Structural Design Standard for Lumber Issued

A COMPREHENSIVE standard for engineering design with lumber is now provided by a national specification just published by the National Lumber Manufacturers Association. Years of research on the strength properties of wood and its fastenings and behavior of lumber structures in service have made possible the first edition of "National Design Specification for Stress-Grade Lumber and Its Fastenings," recommended by the association.

The specification recognizes the value of competent engineering design, accurate fabrication, and adequate supervision of construction, and is intended to promote better engineering design and construction, more efficient use of lumber, and more economical structures.

The specification applies to stress-grade lumber and its fastenings when the lumber is properly identified as to grade. Such identification gives assurance that the lumber conforms to the grade to which the stresses have been assigned.

The material is logically arranged and well cross-referenced for ease in finding specific data and provisions. The detailed development and technical correlation of the specification—under the general supervision of Richard G. Kimbell, director of the Technical and Lumber Standards Divisions, National Lumber Manufacturers Association—was the responsibility of Frank J. Hanrahan, M. Am. Soc. C.E., structural engineer and deputy director of the Lumber Standards Division.

Copies are available at 25 cents each from the National Lumber Manufacturers Association, 1319 Eighteenth Street, N.W., Washington 6, D.C.

## William Benjamin Gregory Laboratory Dedicated

THE late William Benjamin Gregory, M. Am. Soc. C.E., was honored by Tulane University on June 22 at ceremonies dedicating the William Benjamin Gregory Hydraulics Laboratory. An authority in the field of hydraulics, Professor Gregory was professor of experimental engineering and hydraulics at Tulane from 1894 until his retirement in 1938. From the latter year until his death—on January 29, 1945—he held the rank of professor emeritus.

Two members of the Society—Maj. Gen. William Fraser Tompkins and William Monroe White—took part in the ceremonies. General Tompkins delivered the principal address, while Dr. White presented the dedication

## Latin Americans to Receive Highway Training in U.S.

IN RESPONSE to an invitation from the Office of Inter-American Affairs, the American Road Builders Association has set up a training program which will make it possible for 20 highway engineers and construction men from the other republics of this continent to spend one year in the United States studying, working, and gaining actual experience in every phase of highway construction and maintenance. Other organizations sponsoring this program of scholarships or awards are the U.S. State Department, the Public Roads Administration, the Pan-American Highway Confederation, and the Office of Inter-American Affairs.

Application forms and complete information may be secured from the American Embassy or nearest United States consulate. The closing date is October 15, 1945.

Approximately four weeks of the training period will be spent in Washington. Another six weeks will be spent on an inspection trip.

At the conclusion of the trip, each trainee will embark upon a program of practical training and experience planned to meet his individual needs. He will be sent to state highway departments or other groups to obtain first-hand information on American methods. This field work will take up about eight months.

The final month will be spent in Washington. During three weeks of this period, the trainee will work in the laboratory of the Public Roads Administration, studying soil stabilization and the testing of materials. The last week will be given up to general meetings, evaluation, and preparation for the return home. During this final period a short course on traffic control will be made available to those wishing it. Each trainee will be required to prepare a thesis on some subject of his own selection within the scope of his training. If the thesis is approved, it will entitle him to an Inter-American Highway Training Diploma.

## Clearing Maas River in Holland

DUTCH engineers report that they have completed the gigantic task of removing obstacles to navigation in the Maas River two weeks ahead of schedule. One particular incentive was to open the river to barge traffic in order to transport much needed coal from the mines in southern Holland to the western provinces. A second main part of the great project will be the work of complete restoration of locks and bridges.

The work of clearing the 149 miles of the Maas flowing through Holland was extremely difficult, for in addition to the removal of the wrecks in the "ships' cemetery" at Maastricht, near the Belgian border, the engineers also had the job of clearing away the debris of bridges that had plunged into the river. This part of the project included the removal of 15 large spans from the area between the cities of Stein and Nijmegen alone.

Fortunately, enough bridge materials were salvaged to build three new spans. The important Nijmegen Bridge, linking the southern industrial provinces with the northeastern agricultural provinces, has been made ready for rail traffic according to the Netherlands Information Bureau. This is the bridge which the Allies captured last September and around which the battle for Arnhem raged for seven months.

RECONSTRUCTION IN HOLLAND
This Demolished Crane Is Being Salvaged at Amsterdam

**This brief statement regarding our facilities and products may be of interest to newcomers in the water and sewage works fields and may also serve as a reminder to the experienced. Our several foundries, representing the largest plant capacity in the industry, produce Super-de Lavaud centrifugally cast pipe in 12- and 18-foot lengths and diameters up to 24 inches—pit cast pipe in sizes up to 84 inches—with bell-and-spigot, mechanical and flexible joints or with plain ends—and fittings of any size or practicable design. Our headquarters and plant laboratories maintain rigid production controls. Our technical and sales engineering staffs, backed by 45 years of experience, are at your service.**

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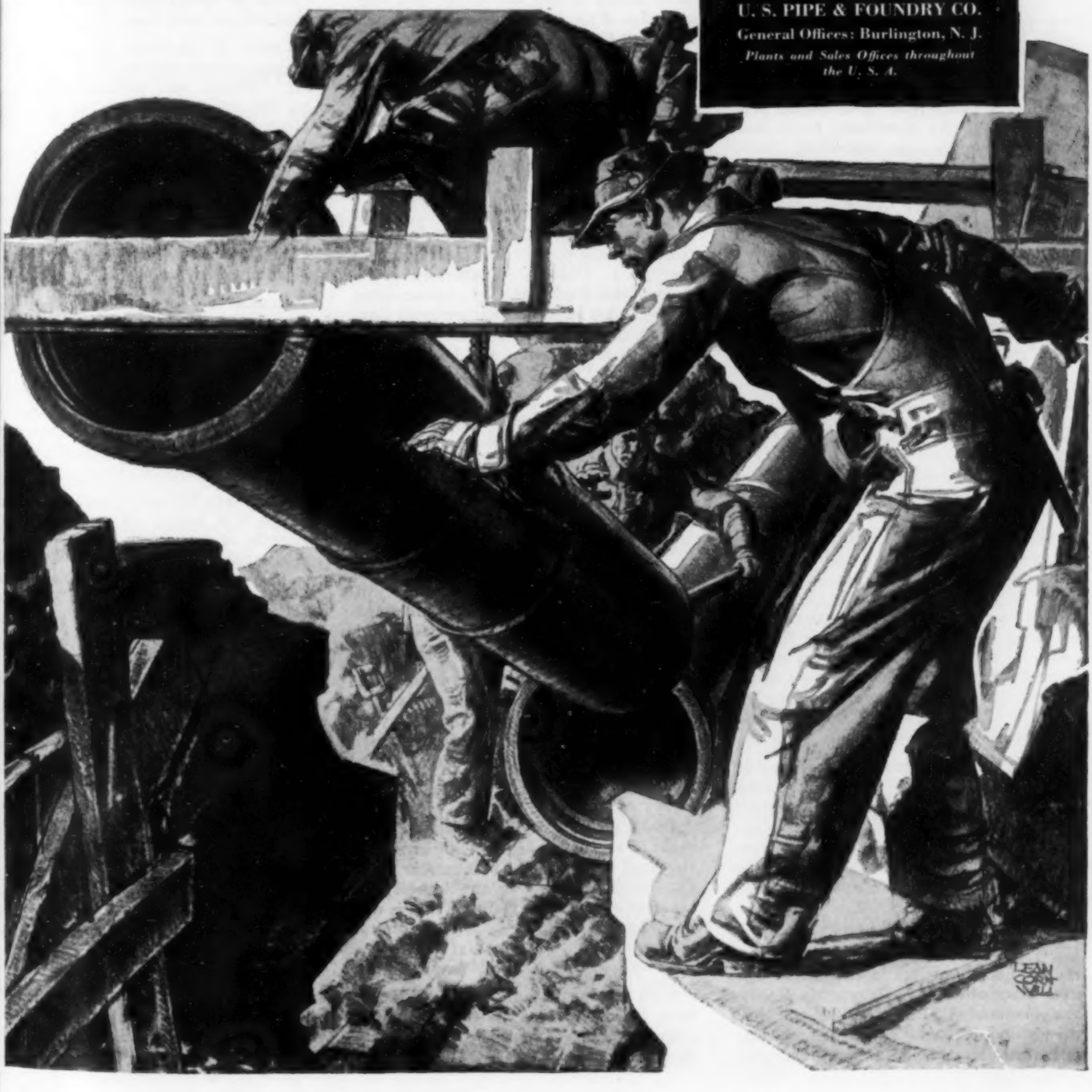
*Drawing by Dean Cornwell*



## Prequalification and License Requirements for General Contractors

A MANUAL, summarizing state prequalification and license requirements for general contractors, was recently issued by the Bureau of Contract Information (Washington 5, D.C.), to serve as a guide to sources of more detailed information. The summary is confined to the more important requirements affecting general contractors and to statutes and regulations concerned solely with construction.

The Bureau cautions the reader that requirements are subject to change without notice and that, therefore, last-minute information should be obtained from the administrative agencies concerned before any important action is taken.

## Manual on Traffic Engineering Studies Available

A 118-page "Manual of Traffic Engineering Studies" has just been published by the National Conservation Bureau, a division of the Association of Casualty and Surety Executives. The manual presents carefully chosen methods, forms, and procedures taken from successful traffic studies and surveys conducted in numerous cities by experienced traffic engineers. It is designed especially to aid communities concerned with maintaining adequate, efficient, and safe transportation on their streets and highways.

The manual sells for $2, and is available upon application to the National Conservation Bureau, 60 John Street, New York 7, N.Y.

## NEWS OF ENGINEERS

*Personal Items About Society Members*

ARTHUR C. NAUMAN, who was recently assigned to new duties as engineering officer at an Army Service Command headquarters in the Philippines, has been promoted from the rank of lieutenant colonel in the U.S. Army Air Force to that of colonel. He is a recent recipient of the Bronze Star Medal with Oak Leaf Cluster for his successful work as engineering officer of the South Pacific Base Command headquarters in New Caledonia.

WALTER H. ROBERTSON has resigned as vice-president of the Massey Concrete Products Company, Chicago, Ill., in order to become manager of piling sales and engineering for the Union Metal Manufacturing Company. His headquarters will be at the company's main plant in Canton, Ohio.

BENJAMIN P. ROBINSON, of Forest Hills, N.Y., has been promoted to the rank of lieutenant (jg) in the Civil Engineer Corps of the U.S. Navy. Mr. Robinson commanded a Rhino ferry in the Normandy invasion and is now public relations officer at Heathfield, Devon, England, headquarters for the 97th U.S. Naval Construction Battalion.

A. FREDERICK GRIFFIN, chief engineer of the Upper Mississippi Valley Division of the Corps of Engineers, St. Louis, Mo., was guest of honor on July 2 at War Department ceremonies, at which he was given the Exceptional Civilian Service Award. Mr. Griffin received this recognition for his "outstanding contribution to the war effort . . . with respect to his direction and conduct of the design of the MacArthur Lock. . . ."

GEORGE J. SCHROEPFER has severed his connection as chief engineer of the Minneapolis–St. Paul Sanitary District in order to become professor of sanitary engineering at the University of Minnesota.

JOHN D. MENDENHALL has been promoted to the position of chief engineer of the Aircraft Division of the Bechtel-McCone-Parsons Corporation, Birmingham, Ala. Until lately he was chief stress engineer in the Aircraft Division, and prior to that had been in charge of structural design during the design and construction of the Birmingham plant, which is reported to be the largest aircraft modification center in the country.

JESSE A. TEAGUE is now in China, where he has been serving with the "Vanguard" squadron of the "Flying Tigers" fighter group of Maj. Gen. C. L. Chennault's Fourteenth Air Force. He has the rank of first lieutenant in the Air Corps. His home is in Bellevue, Tex.

ALBERT B. KOZMA, previously superintendent of the sewage-treatment plant for the Joint Meeting, Rutherford, East Rutherford, Carlstadt, N.J., has accepted a position as assistant engineer with Gannett Fleming Corddry and Carpenter, Inc. His headquarters will be in Harrisburg, Pa.

DUGALD C. JACKSON, professor emeritus at Massachusetts Institute of Technology, was recently awarded honorary membership in the American Society of Mechanical Engineers "for outstanding leadership in education and the consulting engineering fields."

GEORGE D. CLYDE is at present on leave from his position as dean of engineering and mechanic arts at Utah State Agricultural College in order to accept an assignment with the U.S. Department of Agriculture in the field of irrigation research.

RUSSELL C. BAKER was recently promoted from the rank of lieutenant colonel in the Corps of Engineers, U.S. Army, to that of colonel. He is with the Sixth Army on Luzon. Colonel Baker entered the service from Vicksburg, Miss., in March 1942.

GEORGE T. DEAN, who for the past two years has been on leave of absence from the staff of Alabama Polytechnic Institute, while serving with the Seabees, was severely wounded on Okinawa and is now recuperating in the Mare Island Hospital. He has the rank of lieutenant in the Civil Engineer Corps of the U.S. Naval Reserve.

PAUL L. HARLEY and C. T. JUDAH have both been promoted to the position of planning engineer in the U.S. Bureau of Reclamation—the former at Grand Island, Nebr., and Mr. Judah at Lincoln, Nebr. Previously Mr. Harley was an associate engineer in the Denver office of the Bureau and Mr. Judah was an engineer for the Bureau at McCook, Nebr.

CARL E. VOGELGESANG, until lately engineer of road design for the Indiana State Highway Commission, has been appointed chief engineer. Other changes in the department include the appointment of JAMES T. HALLETT, formerly traffic engineer for Indianapolis, as engineer of road design.

C. H. COTTER, rear admiral, Civil Engineer Corps, U.S. Navy, is now director of the Western Pacific Division of the Bureau of Yards and Docks, while REAR ADMIRAL J. J. MANNING has been appointed director of the Eastern Pacific Division, with headquarters in San Francisco. The increased scope of our naval action in the Pacific has made it necessary to subdivide the area that was formerly under Admiral Cotter's control. The new arrangement will enable Admiral Cotter to spend more time supervising construction work in advance areas.

LESLIE W. MAHONE has established an engineering practice in Clear Lake, Iowa. Mr. Mahone was previously supervisor of the Merit System Council at Des Moines, Iowa.

MAX C. TYLER, brigadier general, Corps of Engineers, U.S. Army, is a recent recipient of the Legion of Merit for his work in behalf of the Army's wartime construction program in the Lower Mississippi Valley. General Tyler is president of the Mississippi River Commission.

ELMER A. JACOB, until lately city engineer of Provo, Utah, has been appointed superintendent of the Provo City Utilities Department.

GEORGE F. NICHOLSON, captain, Civil Engineer Corps, U.S. Naval Reserve, is now public works officer and officer in charge of construction at the Hunters Point Navy Yard, San Francisco.

HERBERT MOORE, captain, Sanitary Corps, U.S. Army, writes from Salzburg, Austria, of a visit with DR. KARL IMHOFF, celebrated sanitary engineer. Dr. Imhoff is living in Shaundorf, Germany (just southwest of Munich). He moved to Shaundorf in 1937, appears in good health, and told Captain Moore that he anxiously awaits opportunity to renew associations with his many friends in the United States.

CHARLES EMERSON, of New York; FRANCIS FRIEL and JOEL D. JUSTIN, of Philadelphia; NATHAN JACOBS, of Pittsburgh; and GUSTAV J. REQUARDT, of Baltimore, will constitute a board of five consulting engineers appointed by the Philadelphia Water Commission to make a survey of existing facilities and to report on new sources of supply for the city.

HARRY B. VAUGHAN, JR., major general, Corps of Engineers, U.S. Army, has been placed in command of the Port of Bremen, which is to be the American port for supplying the Army of Occupation in Germany. General Vaughan's most recent assignment was that of head of the United Kingdom Base, Communications Zone, European Theater of Operations.

CLARENCE U. SMITH was recently appointed city engineer of Lindsay, Calif.

CARLOS A. WEBER has been promoted from the position of assistant road engineer for the Michigan State Highway Department to that of road engineer, with headquarters in Lansing.

THOMAS B. CASEY, for the past three years acting chief engineer of the Division of Waterways, Illinois State Department of Public Works, has been appointed chief engineer.

S. S. STEINBERG, dean of the college of engineering at the University of Maryland, is making a three-month good-will tour of Latin American countries in behalf of engineering education. His trip is being sponsored by the U.S. Department of State through its Division of Cultural Cooperation.

RUDOLPH K. BERNARD has severed his connection with the Office of Strategic Service in order to accept an appointment as professor of engineering mechanics at Rutgers University, New Brunswick, N.J.

WILLIAM H. OWEN is now head of the field engineering and inspection department for William S. Lozier, Inc.–Broderick and Gordon, architect-engineer-manager for Sunflower Ordnance Works, DeSoto, Kans. He was formerly senior engineer assistant to the head of this department

## DECEASED

GEORGE MILFORD BAKER (Jun. '39) captain, Infantry, U.S. Army, died in a hospital in Germany on April 12, 1945, as a result of wounds received in action earlier in the day. Captain Baker, who was 29, graduated from the Drexel Institute of Technology in 1938. He then became junior engineer for the Federal Power Commission and later was for several years junior naval architect at the Philadelphia Navy Yard. He entered the Armed Services from Media, Pa., about two years ago.

ROBERT TYRIE BENTON (Jun. '41) lieutenant, U.S. Army, was killed in action over Germany on March 24, 1945. Lieutenant Benton was 29 and an alumnus of the University of Florida, class of 1935. He had been with the U.S. Engineer Department at Ocala, Fla., and Vicksburg, Miss., and from 1939 to 1942 he was in Venezuela engaged in surveying and topographic mapping for the Mott-Smith Corporation, of Houston, Tex. He entered the Army about two years ago. His home was in Gainesville, Fla.

PAUL LEMON BROCKWAY (M. '23) city planning engineer for Wichita, Kans., died in a hospital there on July 20, 1945. Mr. Brockway, who was 66, had been in the service of the city of Wichita for the past thirty-seven years. From 1908 to 1917 he was assistant city engineer, and from the latter year until recently he was city engineer. In 1943 he acquired the additional title of director of public service, but in June of this year ill health forced him to ask to be relieved of both positions, and he became city planning engineer. In spite of years of poor health, Mr. Brockway had been active in the field of municipal administration in addition to his work.

WILBERN GLEN BROWN (Jun. '43) of Berkeley, Calif., was killed in action on Iwo Jima while serving with the U.S. Marine Corps. He was 25 and a graduate of the University of California, class of 1943. Before entering the service, Mr. Brown was a junior engineer at the Kaiser Shipyard at Richmond, Calif.

EDWARD WALLACE BUSH (M. '07) retired engineer of Hartford, Conn., died at his home there suddenly on June 23, 1945, at the age of 73. Early in his career Mr. Bush was with the Connecticut River Bridge and Highway District Commission, serving on the construction of a number of Connecticut bridges. From 1917 until his retirement in March 1944 he was engineer for the Aetna Casualty and Surety Company at Hartford, and was a prime mover in forming the construction division of that organization. An authority on contract specifications, Mr. Bush was invited to assist in the wording of the Boulder Dam and other important contracts. He also contributed numerous articles to the technical press.

FRANK CODAY (Jun. '45) private first class, Infantry, U.S. Army, died on April 9, 1945, of wounds received in action on Okinawa. Mr. Coday, who was 24, received the degree of B.E. from the University of Utah in 1944. His home was in Salt Lake City.

ANDREW JACKSON COOPER (M. '41) manager, Robert and Company, Inc. Atlanta, Ga., died at his home there on July 4, 1945, at the age of 43. Mr. Cooper had been in the employ of Robert and Company for the past twenty years—for four years as manager of the Jacksonville (Fla.) office of the company, in charge of the construction of the Naval Air Station there.

ARTHUR DANIELS (M '23) division engineer for the Chicago, Milwaukee, St. Paul and Pacific Railroad, Minneapolis, Minn., died on June 27, 1945, as a result of injuries suffered in an automobile accident several weeks earlier. Mr. Daniels, who was 60, had spent his entire career with the Chicago, Milwaukee, St. Paul and Pacific Railroad, having gone there in 1903. From 1918 to 1940 he was district engineer at Minneapolis, and from the latter year on division engineer.

LUDLOW VANDERBURG CLARK DEICHLER (Jun. '34) commander, CEC, U.S. Naval Reserve, died on June 27, 1945, at the age of 35. In his early career Commander Deichler had been with several engineering organizations, and for three years he also maintained his own contracting practice in Atlanta, Ga. He entered the U.S. Naval Reserve in October 1939 with the rank of lieutenant (jg). Promoted through the various grades, he became a commander in August 1943. During his period of service with the Navy he had been resident officer in charge of construction at the Naval Air Station at Squantum, Mass., and assistant to the Public Works Officer at Norfolk, Va., and at the time of his death was officer in charge of construction at an advance ba Commander Deichler's home was in Sa Francisco.

HARRY KERCHEVER DEVLIN (Asso M. '36) chief estimator for Gibbs and Hi Inc., of New York, N.Y., died on May 1945, at the age of 53. Though a Canadia by birth, Mr. Devlin had spent his eng neering career in this country, comi here in 1919 after four years of engineeri work with the British Expeditionary Fo in France. He worked on the constru tion of the Hell Gate Power Station i New York, and later was estimator f the Coral Gables Construction Compan at Miami, Fla., and De Riso Brother Inc., of New York. He was estimator f Gibbs and Hill from 1929 to 1936, leavi in the latter year to accept a similar pos tion with the A. L. Hartridge Company of New York. He returned to Gibbs an Hill in 1944.

ARTHUR OSCAR FORSTER (Asso M. '18) of Philadelphia, Pa., died in Jul 1945. He was 63. In his early care Mr. Forster was with the American Brid Company at Pencoyd, Pa., and later a Denver, Colo. He had also been with th American Smelting and Refining Compan in Denver, and was in charge of the desig of the 20th St. Viaduct there for H. S Crocker. Beginning in 1913, Mr. Forste for some years maintained an engineerin and architectural practice in Philadelphi specializing in the design of mill and fac tory buildings.

HENRY HAYDOCK GARRIGUES (M. '1 retired engineer of Philadelphia, Pa., di in Radnor, Pa., on July 15, 1945. M Garrigues, who was 64, was in the eng neering department of the Pennsylvan Railroad from 1901 until his retirement i February of this year. He had been d vision superintendent of the Delawa Division at Wilmington, Del.; gener superintendent at Harrisburg, Pa.; an superintendent of the Philadelphia Te minal Division. At the time of his retire ment he was assistant general manager o the Eastern Region, with headquarters i Philadelphia.

MAURICE NORMAN GERARDY (Asso M. '40) associate engineer for the Detro (Mich.) Department of Water Supply died on June 12, 1945. His age was 4 From 1913 to 1917 and, again, from 191 to 1920, Mr. Gerardy was connected wit Mason L. Brown and Son, Detroit eng neers, interrupting his tenure with th organization to serve in the first Wor War—with the 16th Engineers (Railway Since February 1922 he had been with th Detroit Department of Water Supply, i charge of hydraulic tests and investig tions and plans and specifications.

CHARLES EMIL KAUFFMANN (M. '1 bridge engineer for the City of Atlant Ga., died at his home there on July 6, 194 He was 86. Mr. Kauffmann was born an educated in Germany, coming to th United States in 1881. In 1890 he went t Atlanta, where he was associated, su cessively, with the Atlanta Bridge a Axle Company and the Grant-Wilki Company. From 1910 on he had he the post of bridge engineer for the city, i which capacity he designed the city's pu lic pools, several viaducts and railroa